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ABSTRACT

Reports are presented on the 1970-71 activities of the General Secretariat of the International Telecommunication Union, the International Frequency Registration Board, the International Radio Consultative Committee, and the International Telegraph and Telephone Consultative Committee. In addition progress in the field of space communications made during the year 1969 in 39 nations throughout the world is described and the text of the resolution on international cooperation in the peaceful uses of outer space adopted by the United Nations at its 25th session is given. (JY)

booklet No. 8

TENTH REPORT
by the international telecommunication union
on
TELECOMMUNICATION
AND THE PEACEFUL
USES OF OUTER SPACE

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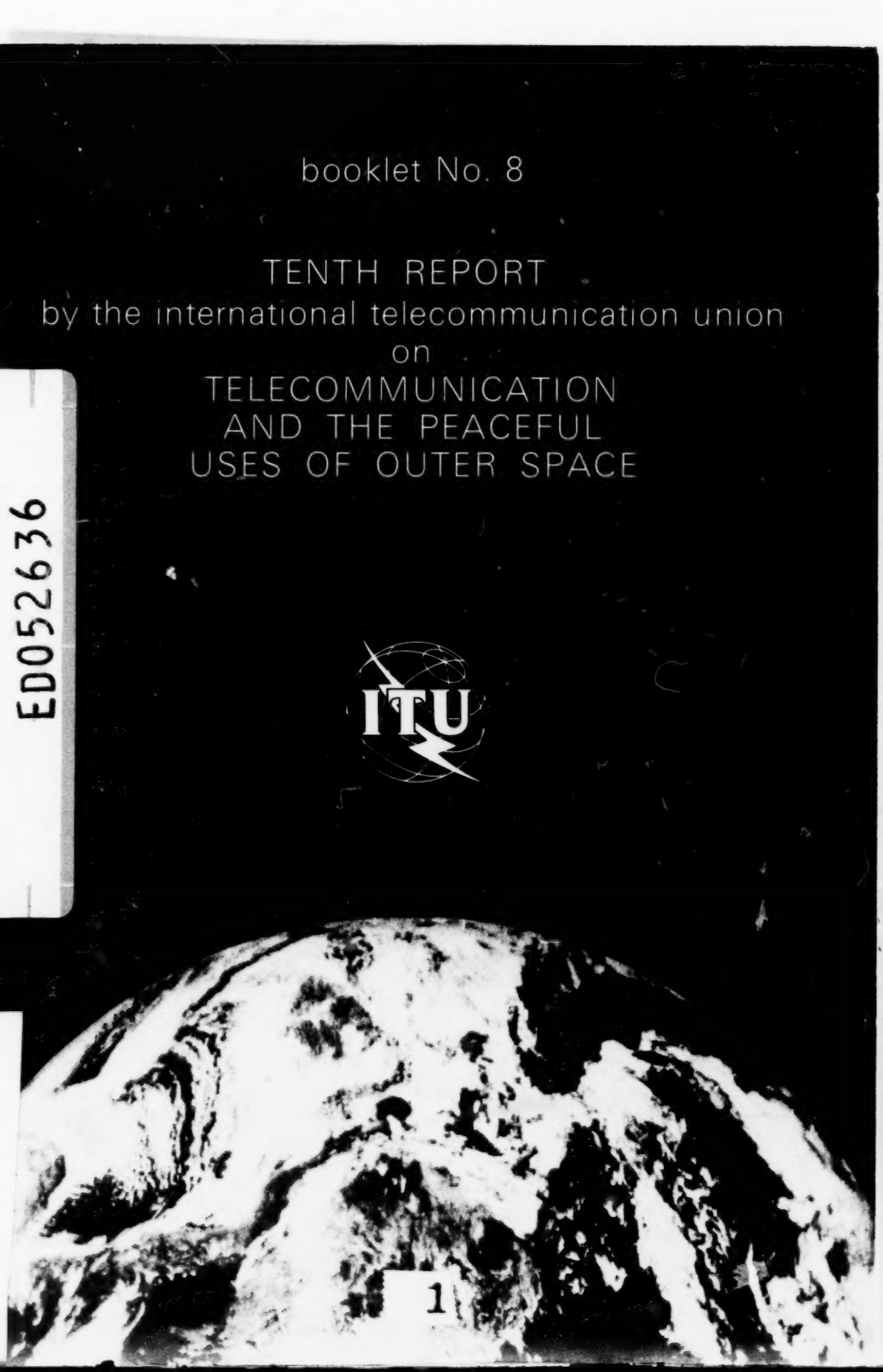

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Book — From semaphore to satellite, 1793-1965 (1965)

Booklet No. 1 — 1865-1965, a hundred years of international co-operation (1967)

Booklet No. 2 — ITU and space radiocommunication (1968)

Booklet No. 3 — Eighth Report by the International Telecommunication Union on telecommunication and the peaceful uses of outer space (1969)

Booklet No. 4 — Symposium "Space and Radiocommunication", Paris (1969)

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tenth report

by the

international telecommunication union

on telecommunication and the peaceful uses of outer space

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Tenth Report of the ITU on telecommunication and the peaceful uses of outer space

1. Introduction

THE present document constitutes a report on the action taken by the permanent organs and the Members of the International Telecommunication Union (ITU) in the field of outer space since the presentation of the Ninth Report in 1970 (see the supplement to the *Telecommunication Journal*, July 1970).

It is submitted for the attention of the United Nations Committee on the Peaceful Uses of Outer Space and of the Economic and Social Council (ECOSOC) and for the information of the Members of the Union.

As was explained in the first report of the series, the international registration of radio frequency assignments for space communications is carried out by a permanent organ of the ITU, the International Frequency Registration Board (IFRB) in accordance with Radio Regulations drawn up by competent ITU Conferences. Technical studies related to the use of telecommunications in outer space are carried out by two other permanent organs, the International Radio Consultative Committee (CCIR) and the International Telegraph and Telephone Consultative Committee (CCITT). Details of the work carried out by these organs are contained in the sections which follow.

Information received from a number of Members of the Union on the progress they have made in the development of space communications during 1969 is contained in Annex 1 to this report and a resolution of the United Nations in Annex 2.

2. Activities of the General Secretariat of the ITU

2.1 Co-operation with other organizations

The General Secretariat of the ITU took an active part in the work of international organizations interested in space communication. It participated in meetings of the United Nations Committee on the Peaceful Uses of Outer Space and of its two Sub-Committees—the Scientific and Technical Sub-Committee and the Legal Sub-Committee—and in meetings of the United Nations Working Group on Direct Broadcast Satellites. The General Secretariat was also represented at

6.

meetings of other Committees and organs of the United Nations, some of whose activities may be concerned with space matters, such as the Economic and Social Council (ECOSOC) and the Administrative Committee on Co-ordination (ACC).

The General Secretariat also took an active part in the work of other specialized agencies such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), and attended meetings of other international organizations, such as the Council of Europe and the Organization of African Unity (OAU), where space questions were discussed.

2.2 Seminars

The various seminars organized by the ITU naturally take account of the introduction of space communications, and, in fact, one of these seminars was entirely devoted to that subject. This Seminar, on the theme "Space telecommunications in the service of progress and co-operation", was organized within the framework of the United Nations Development Programme (UNDP) in co-operation with the Moroccan Administration and took place in Rabat from 7-21 January 1970. Lecturers were made available by the Administrations of Canada, the Federal Republic of Germany, France, Italy, Morocco, the United Kingdom and the United States (see the *Telecommunication Journal*, April 1970, pages 156 and 157).

2.3 Activities in the field of public information and documentation

In pursuance of Administrative Council Resolutions Nos. 636 and 637 on the dissemination of information on the activities and role of the ITU in space communications, in 1970 the General Secretariat embarked on certain activities which are summarized below.

The Union organized three exhibitions on the theme "From semaphore to satellite" in the Youth and Cultural Centres of three French towns fairly close to Union headquarters, Thonon (1 to 17 March), Annemasse (12 to 28 June) and Annecy (7 to 28 July). The exhibitions, which were accompanied by lectures and films, emphasized the importance of international co-operation in space matters. The collaboration between official bodies in France, the United States and the Soviet Union served as an illustration of this principle.

The films dealing with space activities assembled in the Union's film library were in frequent demand.

The *Telecommunication Journal* continued to publish a monthly list of satellite launchings and statistics on the use of communication satellites approximately every six months. In April 1970, a booklet was issued with the "Journal" listing the satellites launched during 1969. Technical or general articles on space questions were published in the July number devoted to "Education and Telecommuni-

cations''. In August another booklet "Ninth Report by the International Telecommunication Union on Telecommunication and the Peaceful Uses of Outer Space'' was included with the "Journal''. Like the preceding report, it was widely circulated and constitutes a highly-appreciated publication.

While the information campaign for the World Administrative Radio Conference for Space Telecommunications continues, work has begun on the preparation of the world telecommunication exhibition TELECOM 71, organized to coincide with the Conference, on the theme "Prelude to the 21st century''. The various aspects of international co-operation and the peaceful uses of space will form an important part of the exhibition.

2.4 Technical co-operation

In 1970 the ITU was actively involved in two space projects—the continuation of activities at Ahmedabad (India) and, in association with UNESCO, the educational television feasibility study for the countries of the Andean region.

■ *Experimental satellite communication earth station, Ahmedabad (India)*

In June 1970, the United Nations Development Programme Governing Council approved a request from the Government of India for 1 068 900 US dollars for the upgrading and equipping of the experimental satellite communication earth station, which is to participate in the India/United States Educational Television (ETV) satellite experiment project. Several meetings were held to determine the work plan, and the expertise and equipment required. Work on antenna design was well under way in India and a "front end'' (input stages) to the receivers was under development in the United States. The formulation of duties of the UNDP/ITU technical co-ordinator for the project was completed and the post advertised—to be filled early in 1971. Part of the equipment required for the experiment—to a value of 670 000 dollars—ten man-years of experts' services and four man-years of fellowships will be furnished by UNDP/ITU. It is envisaged that the highly-skilled expertise required for the project will be obtained by the ITU through subcontracting.

■ *Andean educational television feasibility study*

A joint UNESCO/ITU survey mission to seven countries of the Andean region was completed in the autumn of 1969. The report on this mission recommended a follow-on feasibility study.

Under the United Nations Development Programme (Special Fund) UNESCO, in association with ITU, has been designated as executing agency for the project to assist the governments of countries of the Andean region in South America in making a feasibility study for a regional television system for education and cultural development.

The systems planning and feasibility study proposed will provide a firm basis on which the governments could decide on financing, ownership, organization and operation of a regional education system using a satellite. The study will take into consideration the possible utilization of existing and projected national and intra-regional communications facilities in conjunction with, or as alternative to, a satellite system.

The study will also comprise the elaboration of *ad hoc* teaching techniques to reach the largest possible school-age and adult audience with appropriate educational and information programmes.

The ITU will appoint a system planning co-ordinator, a receiving system engineer and a satellite system planning engineer. Moreover, the ITU will subcontract part of the technical studies to be performed within the scope of the project to consulting firms, as and when required.

3. Activities of the International Frequency Registration Board (IFRB)

3.1 Since the publication of the Ninth Report, the IFRB has continued to apply the relevant provisions of the Radio Regulations annexed to the International Telecommunication Convention, in connection with frequency assignment notices for space communications received from administrations. The Board received 236 such notices in 1970. The relevant notification and registration procedures are defined in Article 9A of the Radio Regulations.

3.2 The Board has prepared and adopted the revised version of the chapter of its Rules of Procedure relating to the processing of notices of frequency assignments to stations which use the bands shared by the space service and terrestrial (fixed and mobile) services with equal rights. For this purpose and as a result of the work of Study Group 4 of the CCIR, which deals with space radiocommunications, the Board has brought up to date adequately its technical standards related to the technical examination of frequency notifications for these services, for application of the regulatory provisions contained in the Final Acts of the Extraordinary Administrative Radio Conference to allocate frequency bands for space radiocommunication purposes, Geneva, 1963.

3.3 Furthermore, the ITU has published all particulars of the earth and space stations which were recorded in the Master International Frequency Register, in the "List of stations in the Space Service and in the Radio Astronomy Service" prepared by the IFRB. The second and third recapitulative supplements to the second edition of that List have been issued during the year 1970.

3.4 The Board also participated actively in the work of other international organizations dealing with space communications. For example, it attended various UNESCO meetings devoted to the study of UNESCO projects for the use of satellites in educational broadcasting as well as to the study of satellite broadcasting in general. It was represented at the meetings organized by the Inter-Governmental Maritime Consultative Organization (IMCO) on the use of satellites for the radionavigation and communication requirements of merchant shipping and contributed to the work of the Inter-Union Commission on Allocation of Frequencies for Radio Astronomy and Space Science (IUCAF) in radio astronomy. While the Board does not actually take part in the work of the ASTRA Panel* set up by the International Civil Aviation Organization (ICAO) to study aeronautical space communication requirements, it nevertheless made a study of the reports drawn up by the Panel during its meetings.

3.5 Under No. 482 of the Radio Regulations, the Board has initiated the technical preparation of the forthcoming World Administrative Radio Conference for Space Telecommunications, Geneva, June-July 1971. In this connection, after having examined the matters which may be of interest to the Conference, it has undertaken the study of technical characteristics of space systems and related services using the shared bands, mainly from the point of view of the regulatory aspects, as well as the optimum utilization of the frequency spectrum and of the geostationary-satellite orbit. In this study, the Board closely analyzes the progress achieved in those fields by the various CCIR Study Group meetings.

3.6 In accordance with the provisions of Resolution No. Spa 1 adopted by the Extraordinary Administrative Radio Conference, Geneva, 1963, the IFRB published in 1970, in a special section of its weekly circular, information providing a general description of a satellite system, received from the Administration of Canada. This information relates to the launching and use of a research satellite *Isis (B-2)* designed to obtain information about the earth's ionosphere. This satellite is part of an international scientific programme which has provided the earlier Canadian-built satellites *Alouette-I*, *Alouette-II* and *Isis-I*.

3.7 The frequency assignment notices received and dealt with by the IFRB in 1970 concerned mainly the establishment or modification of space systems and the implementation of experimental programmes. By its weekly circular, the IFRB regularly communicated to administrations the detailed information contained in all notifications it received, as well as the findings it reached in accordance with the provisions of Article 9A of the Radio Regulations. Those notices are briefly described in the table on pages 10-12.

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* Application of Space Techniques Relating to Aviation.

3.8 Part of the Seminar on frequency management and the use of the radio frequency spectrum which the Board organized in 1970 at Union headquarters was devoted to space matters (see the *Telecommunication Journal*, February 1971, pages 63 and 64). Lecturers sent by administrations as well as officials of the IFRB explained in detail to 86 participants the regulatory and technical aspects of the use of the radio frequency spectrum for space telecommunications. They particularly dwelt on regulations and the calculation of co-ordination distance, on which practical exercises were conducted. A member of the Board also gave a lecture on the same subjects during the ITU Seminar on space communication in the service of progress and co-operation organized in Rabat in January 1970 (see the *Telecommunication Journal*, April 1970, pages 156 and 157).

Table

country	system or programme	notices received and dealt with by the IFRB in accordance with the provisions of Article 9A of the Radio Regulations
Belgium	— international governmental communication-satellite system *(Satcom-2)*	— earth station Heide (transmission, reception, tracking)
Canada	— INTELSAT programme *(Intelsat-III)*	— earth station Mill Village (Nova Scotia) (transmission, reception, tracking)
	— international governmental communication-satellite system *(Satcom-2)*	— earth station Carp (Ontario) (transmission, reception, tracking)
Korea (Republic of)	— INTELSAT programme *(Intelsat-III)*	— earth station Kum San (transmission, reception)
Denmark	— international governmental communication-satellite system *(Satcom-2)*	— earth station Lundbakke (transmission, reception, tracking)
United States of America	— INTELSAT programme *(Intelsat-IV)*	— space station *Intelsat-IV* (Atlantic) (transmission, reception, tracking, telemetering)
	— international governmental communication-satellite system *(Satcom-2)*	— earth station Norfolk (Virginia) (transmission, reception, tracking)
	— space research programme *Nimbus-D*	— space station *Nimbus-D* (telemetering)
		— earth station Fairbanks (Alaska) and Rosman (North Carolina) (telemetering)

country	system or programme	notices received and dealt with by the IFRB in accordance with the provisions of Article 9A of the Radio Regulations
France	— space research programme *Eole*	— space station *CAS-A* (telemetering, tracking, telecommand) — earth stations on board stratospheric balloons (telemetering) — earth stations Brétigny and Kourou (French Guyana) (telemetering, tracking, telecommand)
Greece	— international governmental communication-satellite system *(Satcom-2)*	— earth station Atalanti (transmission, reception, tracking)
Iran	— INTELSAT programme *(Intelsat-III)*	— earth station Asadabad (transmission, reception)
Italy	— INTELSAT programme *(Intelsat-III)*	— earth station Fucino (transmission, reception)
	— international governmental communication-satellite system *(Satcom-2)*	— earth station Piana Chiavica (transmission, reception, tracking)
Japan	— INTELSAT programme *(Intelsat-III)*	— earth station Ibaraki and Yamaguchi (transmission, reception)
	— experimental communication-satellite earth station	— earth station Kashima Ibaraki (transmission, reception, tracking) in relation with a satellite of the *ATS* (Applications Technology Satellites) series
	— space research programme *Todai-F2*	— space station *Todai-F2* (transmission, reception, telecommand) — earth station Uchinoura (transmission, reception, telecommand)
Kenya	— INTELSAT programme *(Intelsat-III)*	— earth station Mount Margaret (transmission, reception)

country	system or programme	notices received and dealt with by the IFRB in accordance with the provisions of Article 9A of the Radio Regulations
Norway	— international governmental communication-satellite system *(Satcom-2)*	— earth station Eggemoen (transmission, reception, tracking)
Netherlands (Kingdom of the)	— international governmental communication-satellite system *(Satcom-2)*	— earth station Schoonhoven (transmission, reception, tracking)
Portugal	— international governmental communication-satellite system *(Satcom-2)*	— earth station Costa Caparica (transmission, reception, tracking)
Federal Republic of Germany	— international governmental communication-satellite system *(Satcom-2)*	— earth station Euskirchen (transmission, reception, tracking)
	— space research programme *Wika*	— space station *Wika* (transmission)
United Kingdom of Great Britain and Northern Ireland	— INTELSAT programme *(Intelsat-III)*	— earth station Ras Abu Jarjur (Bahrain) (reception)
	— international governmental communication-satellite *(Satcom-2)*	— earth station Oakhanger (transmission, reception, tracking)
Singapore (Republic of)	— INTELSAT programme *(Intelsat-III)*	— earth station Sentosa Singapore (transmission, reception)
Sweden	— INTELSAT programme *(Intelsat-IV)*	— earth station Tanum (transmission, reception, tracking)
Turkey	— international governmental communication-satellite system *(Satcom-2)*	— earth station Yoncalik (transmission, reception, tracking)

4. Activities of the International Radio Consultative Committee (CCIR)

The XIIth Plenary Assembly of the CCIR was held in New Delhi, India, during January 1970. At this Assembly, the developments being made in space telecommunications techniques were incorporated in the CCIR recommendations and

reports. However, developments in space telecommunications technology are being made very rapidly, so that, following a proposal by the Administrative Council, the Plenary Assembly decided to convene a special meeting of the Study Groups concerned, in February 1971, so that the World Administrative Radio Conference for Space Telecommunications can proceed on the basis of the latest technical information. Progress being made by the CCIR on the following topics is of particular importance:

4.1 Use of frequency bands above 10 GHz for point-to-point communication-satellite systems

The use of satellites for relaying point-to-point telecommunications of all kinds (telegraph, telephone, data) has expanded greatly, particularly since the development of the geostationary satellite, so that frequencies allocated for this service are becoming congested. The possibilities of sharing frequencies by various users is a principal area of study by the CCIR. With the anticipated requirements for additional point-to-point communication satellites and with the advance of techniques using higher frequencies, the CCIR is studying the capabilities of frequencies above 10 GHz for this purpose.

Attenuation due to scatter, absorption by clouds and precipitation increases as frequencies exceed 10 GHz. Heavy rain in the vicinity of an earth station can cause deterioration in system performance at these frequencies. Space diversity, using two (or more) earth stations separated by a suitable distance provides a possibility to overcome this deterioration.

CCIR studies demonstrate that frequency sharing between space and terrestrial systems should present fewer difficulties on the higher frequencies, since signals are more highly attenuated with distance of travel and the presence of obstacles and the distance over which they are likely to interfere with a co-channel service is reduced.

4.2 Technical factors influencing the efficiency of use of the geostationary-satellite orbit by communication satellites sharing the same frequency

The maximum coverage of the surface of the earth from a particular geostationary satellite is limited by geometrical considerations.

The distribution of population, the need for telecommunication services and other considerations make heavy demands on certain sectors of the geostationary-satellite orbit, which may well become congested in the future. Furthermore, emissions from terrestrial radio-relay systems may cause harmful interference to geostationary satellite-communication systems.

In order to evaluate the possibilities of many satellites sharing the geostationary orbit, without the occurrence of harmful interference between them, the CCIR is investigating the influence of the various technical factors determining the mutual interference. These include:

a) tolerable levels of interference in different communication satellite systems and their apportionment;

b) differences in the values of radiated powers used by earth stations and satellites;

c) required protection ratios resulting from various modulation processes;

d) multiple use of the same frequency by the same satellite;

e) satellite position accuracy and attitude, and

f) polarization of radiation.

These studies are expected to provide a sound technical basis for determining the separation of satellites in the geostationary orbit required to avoid interference.

4.3 The application of satellite techniques to sound broadcasting and television

Of considerable recent interest to a number of administrations is the possibility of broadcasting from satellites, since large areas of the earth may be directly and continuously illuminated from a geostationary satellite or, by the use of directional antennae, the illumination may be at least partially restricted to a particular limited area on the earth with a corresponding increase in signal strength. The application of broadcasting satellites is being considered as a possibility for distributing educational programmes over large areas, particularly in countries which have little or no terrestrial communication networks suitable for this purpose such as may be the case in new and developing countries.

The CCIR has studied the technical factors of broadcasting both sound and television programmes from satellites and has determined the power, bandwidth, signal levels and interference criteria required to provide such a service. In addition, it is including in its studies the relative economic factors between various methods of providing such service whether by terrestrial lines or microwaves or by a satellite distribution network to terrestrial rebroadcasting stations, community receiving stations, or direct-to-home reception. The results of the CCIR studies have indicated that, although it is technically feasible to broadcast from satellites, relatively large amounts of satellite effective radiated power are necessary to provide a satisfactory service from a satellite in the geostationary orbit to the surface of the earth, in particular for direct-to-home reception and that sharing of frequencies between satellites and terrestrial broadcasting services would result in harmful interference except under special circumstances. Reports on the CCIR XIIth Plenary Assembly dealing in particular with these questions are:

a) frequency sharing between the broadcasting-satellite service and terrestrial services in technically suitable bands;

b) recommended characteristics for collective and individual antenna systems for domestic reception of signals from terrestrial transmitters;

c) specifications of low-cost receivers.

4.4 Communication satellites and the mobile services

The CCIR, in close co-operation with the ICAO and IMCO, has continued its studies on the feasibility of systems employing space-communication techniques for the aeronautical and maritime services.

The CCIR reports, adopted at the XIIth Plenary Assembly, dealing with the technical characteristics for satellite communications for aircraft and ships, served as basis for discussion at the third meeting of ICAO ASTRA Panel. This Group of Experts, using the results of the CCIR, compared the respective advantages and disadvantages of operating aeronautical satellite communications, in bands 8 (VHF) and 9 (UHF), with a view to studying the advantages of one or the other band for such communications. Although considerable data exist in the above-mentioned texts, the studies are continuing, since no measured values are available for a number of phenomena, or values could be obtained only by extrapolation (for example, polar-cap absorption, noise, etc.). Values for multipath losses could be assumed only on the basis of theoretical studies. The Special Joint Meeting of CCIR Study Groups will study these problems including the results of a number of experiments which have been carried out in recent months.

At its seventh session, the Sub-Committee on Radiocommunications of IMCO drew up a statement of maritime requirements for the application of space techniques to the maritime mobile service. Distress alerting and search and rescue control communications are the most important of these requirements.

Consideration has been given to the feasibility of sharing the same frequency bands and/or the same system when using space communication techniques for the aeronautical and maritime service.

5. Activities of the International Telegraph and Telephone Consultative Committee (CCITT)

5.1 The CCITT is studying the use of communication satellites for telegraph, facsimile, telephone and data transmissions and, where necessary, the signalling associated with these various types of transmission. A large number of Study Groups has contributed to this work.

5.2 Study Group XII (Telephone transmission performance and local telephone networks) considers that, for the present, the propagation time limits given in Recommendation G.114 in Vol. *III* of the *White Book* (Recommendation P.14 in Vol. *V* of the *Blue Book*), as approved by the IVth Plenary Assembly (Mar del Plata, 1968), should remain unchanged. The Study Group has, however, investigated ways of improving the quality of communications with very long propagation times, in particular by the use of adaptive echo cancellers.

The limits laid down in Recommendation G.114 are based on speech transmission quality; error correction in data transmission may present difficulties when propagation time is long and the question is now being studied by Special Study Group A (Data transmission)—Question 1/A, point AC: use of circuits established by means of satellite for data transmission.

5.3 Study Group XVI (Telephone circuits) has studied the transmission problems raised by the introduction of satellite systems providing demand assignment telephone circuits.

Study Group XIII (Automatic and semi-automatic telephone networks) is well aware that the international routing plan may require amendment a few years hence if demand assignment of circuits becomes a common practice. A question on this subject is under study which it is hoped will be completed by the beginning of 1972.

5.4 The programme of Study Group IV (Transmission maintenance of international lines, circuits and chains of circuits) includes the maintenance of satellite circuits, which poses some new problems, particularly as the composition of such circuits is not defined in the same way as in conventional systems, which means that maintenance management and clearing of faults are much more complicated.

5.5 Special Autonomous Working Party 3 (Economic and technical comparison of transmission systems) has collected information on telecommunications satellites. The Editorial Committee of GAS/3 has already prepared the broad outlines of draft texts to supplement the manual on "Economic and technical aspects of the choice of transmission systems".

5.6 The new signalling systems recommended for telex and telephony take the peculiarities of satellite circuits into account.

5.7 Study Group II (Telephone operation and tariffs) is studying the tariff problems raised by the use of satellite circuits for telephony.

5.8 The Joint CCITT/CCIR Study Groups administered by the CCITT have also to deal with communication satellites. However, Special Study Group C (Noise) will meet during 1971. The Plan Committee for Asia and Oceania has asked the International Consultative Committees to undertake a study of the technical and economic aspects of a domestic and/or regional satellite system, while the Plan Committee for Europe and the Mediterranean Basin has issued an opinion on the co-ordination and development of satellite communications.

ANNEX 1

Reports on progress made in the development of space communications

ARGENTINE REPUBLIC

1. Satellite communication

The services were operated by *Empresa Nacional de Telecomunicaciones* (ENTEL) as far as the Balcarce earth station and the telephone and telex operating centres, the *Centro Internacional Buenos Aires* (CIBA) were concerned and by the *Centro Internacional de Operación Telegráfica* (CIOT) of the State Secretariat for Communications.

1.1 Balcarce earth station

Operation continued with the basic equipment of 1969, with a mean reliability of 99.81% for the earth station and 99.60% for the terrestrial link.

Preliminary studies were undertaken and contracts were awarded for the supply and installation of equipment for the enlargement of Balcarce 1 and to fit out the new complex named Balcarce 2.

As from 1971 it will thus be possible to:

— set up a simultaneous link with two satellites in the Atlantic region. One of these will be *Intelsat-IV*;

— provide antenna redundancy so that the traffic can be switched from one system to the other in the event of faults;

— conduct measurements on an antenna system without interrupting the service;

— receive two television programmes simultaneously.

1.1.1 Balcarce 1

The enlargement of Balcarce 1 applied mainly to the transmission sub-system.

— *Power amplifiers*

In addition to the two existing 3 kW transmitters there will be a 400 W (200 W + 200 W) self-redundant transmitter with travelling wave tubes and a 500 MHz bandwidth.

— *Exciters*

Two further exciters with tuning control will be added to the present ones and one for the Spade (Single channel per carrier PCM multiple access demand assignment equipment) service.

1.1.2 Balcarce 2

— *Antenna*

An antenna with a parabolic reflector 29.95 m in diameter and with similar electrical characteristics to the present one is under construction. The mechan-

ical systems have been improved, resulting in a reduction in the number of rotating joints; waveguide losses will be lower and the torsion moments in the azimuth axis will be reduced.

— *Power amplifiers*

Four amplifiers with travelling wave tubes, each of 1.2 kW and 500 MHz bandwidth will be installed.

— *Exciters*

Four exciters with tuning control will be installed. This variant will facilitate all possible combinations with Balcarce 1. An exciter for the Spade service is also planned.

— *Reception*

The sub-system has built-in redundancy and is similar to Balcarce 1.

1.1.3 Equipment common to Balcarce 1 and Balcarce 2

— *Modulators*

Four modulators for telephony and one for television similar to the existing ones will be added.

— *Receivers*

The following equipment, together with their corresponding standbys will be added:

— 750/70 convertors: nine for telephony and one for television.

— demodulators: nine for telephony and one for television.

The telephone demodulators have an extendible threshold.

Spade equipment with 12 initial channels and corresponding 750/70 MHz convertors.

— *Power*

A third 250 kVA generating set will be added; with the two existing ones this will make a total of 750 kVA.

— *Link with the Buenos Aires switching centres*

Reliability will be increased, since the links are being extended by the laying of a coaxial cable between Balcarce and Mar del Plata; this will complete the second route between Balcarce and Buenos Aires.

Antenna under construction at the Balcarce (Argentina) earth station

(Ministerio de Obras y Servicios Públicos, Argentina)

— *Console*

The functions will be divided between three different operating centres: antenna, equipment and television.

— *Balcarce 1—Balcarce 2 interconnection*

Switching circuits will permit interchanges between the two systems. The transmission switching will be at 70 MHz and the reception at 750 MHz.

1.2 Centro Internacional Buenos Aires (CIBA)

1.2.1 Telephony

— In 1970 the CIBA telephone exchange was equipped with the *ESK-Siemens* technique, with an initial capacity of 63 circuits.

DIAGRAMME N° 1 - TRAFIC TELEPHONIQUE DE DEPART ACHEMINE PAR SATELLITE
GRAPH No. 1 - OUTGOING TELEPHONE TRAFFIC VIA SATELLITE
GRÁFICO N.° 1 - TRÁFICO TELEFÓNICO DE SALIDA VÍA SATÉLITE

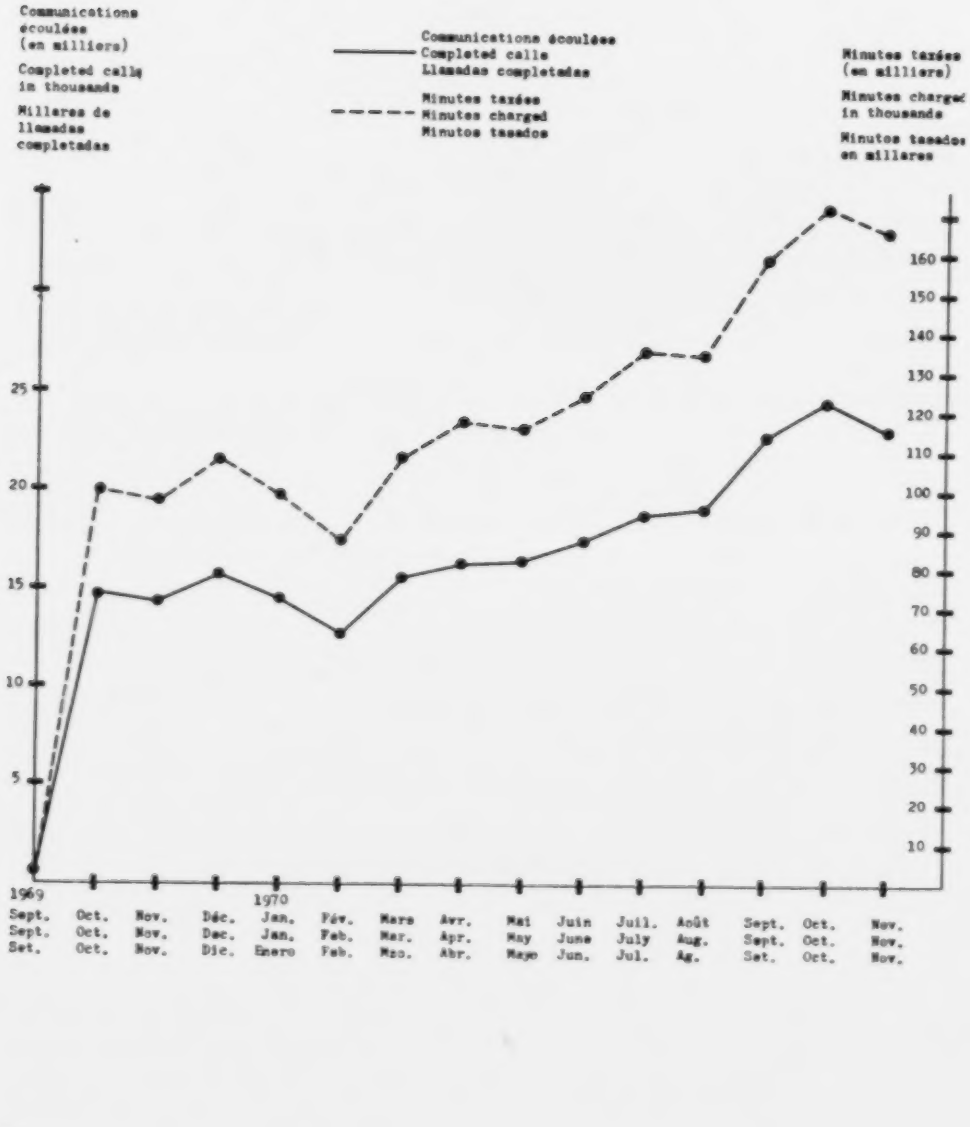
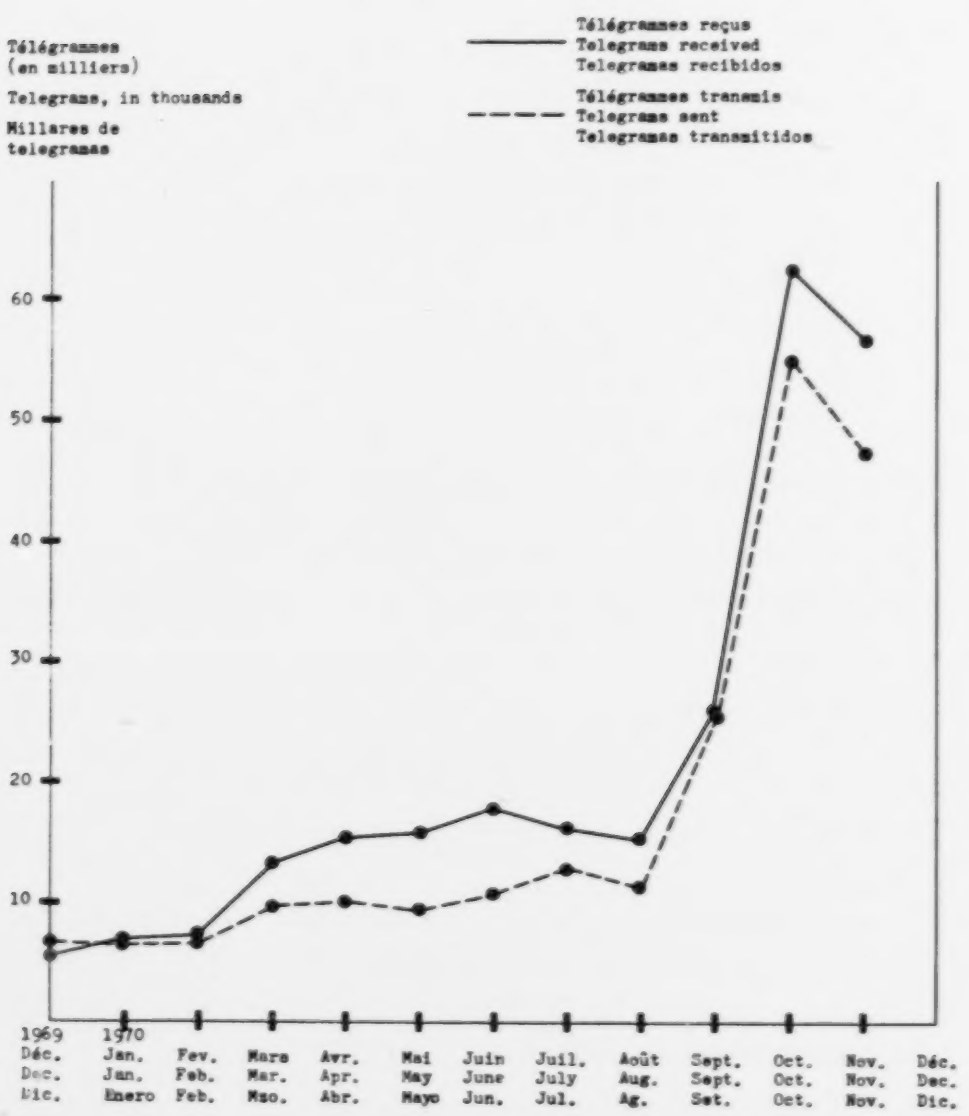


DIAGRAMME N° 2 - TRAFIC TELEGRAPHIQUE ACHEMINE PAR SATELLITE
GRAPH No. 2 - TELEGRAPH TRAFFIC VIA SATELLITE
GRÁFICO N.° 2 - TRÁFICO TELEGRÁFICO VÍA SATÉLITE



— Direct connections with the following countries are now available:

	(circuits)
Italy	5
Colombia	1
Brazil	8
Peru	3
Germany	3
Switzerland (via Germany)	1
Canada (via the United States)	1
United Kingdom (via Germany)	2
France	3
Spain	3
United States	18
Chile	11
Mexico	1
Venezuela	2

This makes in all, 62 manual and semi-automatic telephone circuits.

Extension up to 150 circuits is scheduled for the near future.

— By November 1970 completed outgoing calls were averaging 18 250 a month. Charged minutes averaged 129 100 a month.

1.2.2 Telex

— An EMD telex exchange with the following features is available:

— incoming circuits	90
— automatic outgoing circuits	66
— manual or semi-automatic outgoing circuits	38

The gradual equipment over the next three years of an ESK (TWKD) telex exchange of 410-circuit capacity is planned.

— In 1970, 63 circuits with point-to-point service were leased, thus making a total of 194 circuits which carried a monthly average of 27 900 outgoing calls and registered 121 600 charged minutes.

1.3 Centro Internacional de Operación Telegráfica (CIOT)

1.3.1 This operating centre has been handling the entire international telegraph traffic since October. It has 8 sending and receiving circuits.

Buenos Aires — New York	1 circuit with Western Union International Inc. 1 circuit with RCA Global Communications Inc. 1 circuit with World Communications Inc.
Buenos Aires — Rome	1 circuit with *Italcable Servizi Cablografici, Radiotelegrafici e Radioelettrici SA*
Buenos Aires — Rio de Janeiro	1 circuit with the *Emprêsa Brasileira de Telecomunicações*
Buenos Aires — Hamburg	1 circuit with the Ministry of Posts and Telecommunications
Buenos Aires — London	1 circuit with the United Kingdom Post Office
Buenos Aires — Santiago	1 circuit with the *Administración Chilena de Telecomunicaciones*

and 1 circuit, for reception only, with Vienna *(EPER Radio Austria)*.

Six additional circuits are scheduled for 1971.

1.3.2 During the first nine months in which the services were operated in conjunction with four other companies, there was a monthly average of 11 482 telegrams sent and 14 945 received.

From October the monthly average for the first two months of exclusive operation was 51 626 telegrams sent and 60 157 received.

2. Space research

The space research programmes are carried out by the *Comisión Nacional de Investigaciones Espaciales* (CNIE), National Committee for Space Research.

2.1 The following work was carried out in 1970:

2.1.1 "Exametnet" programme

The purpose of this programme is to study winds and temperatures up to a height of 80 km. It is a joint programme with the United States National Aeronautics and Space Administration (NASA), and the *Comissão Nacional de Actividades Espaciais* (CNAE), Brazil. Meteorological rockets were launched fortnightly from

the *Centro Espacial de Lanzamientos para la Prospección Atmosférica* (CELPA)—Atlantic—Mar Chiquita base. These launchings were weekly during wind inversion periods.

2.1.2 "Galaxia" programme

Its aims are to measure cosmic rays, chemical composition, high-energy particles and to study X and gamma ray astronomy. It is a joint programme with the Rice and New Hampshire Universities, the NASA MSG Space Physics Division and the United States National Center for Atmospheric Research (NCAR). Superballoons were launched from the balloon launching pad of the city of Paraná.

2.1.3 "AER-70" programme

This is a joint research programme with the *Centre national d'études spatiales* (CNES), France. *Rigel* and *Bélier-Centaur* rockets were launched with a payload of alkaline clouds.

2.1.4 "Dragon-70/71" programme

A joint programme for cosmic ray research with the University of Tucumán and the CNES (France).

Dragon rockets were launched from the CELPA—Atlantic base.

2.1.5 Trajectography

Trajectories for sounding rockets are determined by means of interference-measuring systems.

2.1.6 Developments

— Earth telemetry stations are being developed on the basis of IRIG FM/FM proportional and constant band standards. This is a joint programme with the Space Electronics Laboratory of the Buenos Aires Engineering Faculty.

— Telecommand systems for balloons were developed for the purpose of scientific experiments.

2.2 The above work will continue in 1971 and the following will be added:

2.2.1 *"Arus-Ion" programme*

This is an ionospheric research programme in conjunction with NASA and the University of Illinois. It consists in launching two *Orion* rockets from Wallops Island and Mar Chiquita. Preliminary launchings with payload were made during 1970.

2.2.2 *"Arbras" programme*

A joint programme for cosmic ray research with the CNAE (Brazil) and the *Centro Nacional de Radiación Cósmica* (CNRC) National Cosmic Radiation Centre of Argentina. Two *Orion* rockets were launched from the Barreira do Inferno (Brazil) base.

2.2.3 *"Astro-X" programme*

This is a research programme on galactic X-ray sources conducted jointly by the CNRC and the University of Córdoba (Argentina). It comprises the launching of two *Rigel* rockets from the CELPA—Chamical base.

2.2.4 *"Arit-Astrox" programme*

The aim of this programme is to carry out research into X-rays in conjunction with the *Consiglio Nazionale delle Ricerche* (CNR—Scientific Research Council), Italy. It consists in launching a *Rigel* rocket from the CELPA—Atlantic base.

2.2.5 *"Arit-Ion" programme*

This is a joint programme of ionospheric research with the CNR (Italy). A *Rigel* rocket is to be launched from the CELPA—Atlantic base.

2.2.6 *"Eole" programme*

A joint programme of meteorological research at 200 mb level with the CNES (France). 500 balloons, which will operate through the French *Eole* satellite, are to be launched from bases in Mendoza, Neuquén and Tierra del Fuego.

2.2.7 *The "Arus-Astrox" programme*

Research into galactic X-rays by means of sensors on stabilized platforms carried by balloons. This is a joint programme with research centres in the United States.

3. Meteorology

Meteorological services have been operating since 1966 and their tasks are divided between the General Directorate of the National Meteorological Service, coming under the Air Force, and the Meteorological Service of the Argentine Navy (SMARA — *Servicio Meteorológico de la Armada Argentina*).

3.1 Meteorological Service of the Argentine Navy

3.1.1 The service has two APT (Automatic Picture Transmission) satellite-earth receiving stations, one sited at Vicente López (province of Buenos Aires) and the other in Río Gallegos (province of Santa Cruz).

In 1970, cloud data and infrared pictures were received without interruption from the following satellites while they were in operation:

Nimbus-III	cloud covers, infrared night pictures
Essa-8	cloud covers and other features
Itos-I	cloud covers, other features and day and night infrared pictures
Itos-II	data were picked up from this satellite but it is not yet operational.

3.1.2 The following programmes were also carried out:

— 1970-71 "Antarctic campaign". Glaciological data from satellites were transmitted;

— synoptic-climatological research studies based on data received from satellites.

3.2 The General-Directorate of the National Meteorological Service

The following programme was executed in 1970.

3.2.1 "Ghost" project

This is a co-operative programme with constant pressure level balloon tracking.

3.2.2 Reception from satellites with APT receivers, interpretation and dissemination of meteorological data.

3.2.3 "Exametnet" programme

This programme is co-ordinated with the CNIE planning and launching of meteorological rockets for wind and temperature measurements.

4. Radioastronomy

Three specialized institutes conduct the research: the La Plata Observatory, the Argentine Institute for Radioastronomy and the San Miguel National Observatory of Cosmic Physics.

4.1 La Plata Observatory

4.1.1 In 1970 observations on 408 MHz were made with a 6.6 m diameter parabolic radiotelescope, with a main lobe width of 7°.

The bandwidth of the receiver was 1 MHz.

Studies were made of the solar corona, electronic densities and temperatures associated with solar phenomena, and of the slowly variable component.

4.1.2 The plan of work drawn up for 1971 comprises the following items:

a) continuation of previous work with the same receiver but with the addition of an interferometer with the following characteristics:

— frequency	408 MHz
— lobes	$5° \times 8'$
— angle between lobes	1.43°
— overall length	318 m

b) solar corona studies associated with pulse phenomena on the solar corona will be undertaken and measurements will be taken of, *inter alia*, brightness temperatures and coronary condensation.

Dipole systems with the characteristics listed below will be used:

— frequencies	36 MHz and 170 MHz
— lengths	60 λ and 300 λ respectively
— bandwidth of the receivers	400 kHz

c) ionospheric absorption connected with solar flares will be studied.

A receiver for atmospheric noise detection will be used at 21 MHz;

d) use of a 100 to 170 MHz scanning receiver fitted with an interferometer and a polarimeter is on the programme.

4.2 Argentine Radioastronomy Institute

4.2.1 During 1970 studies were mainly carried out on:

— galactic structure, through the distribution of neutral hydrogen in the 21 cm line (1420 MHz);

— extra-galactic radio sources in the continuum.

Studies were conducted with a 30 m diameter radiotelescope in a bank of 56 channels of 10 kHz bandwidth and 20 kHz separation. In the continuum the receiver has a bandwidth of 8 MHz.

4.2.2 The following studies are planned:

— in the galaxy in the OH, HI and hydrogen recombination lines, and in the continuum;

— extra-galactic objects.

A second 30 m diameter parabolic radiotelescope with the following characteristics will be commissioned shortly; it will be able to function on its own or as an interferometer with the present one:

— spacing	between 100 and 800 m
— frequencies	1420 to 1427 MHz 1664 to 1668 MHz 2690 to 2700 MHz

4.3 National Observatory of Cosmic Physics — Department of Radioheliography

4.3.1 Embarking on its activities in 1970, it effected the following studies:

— solar radioastronomy in the 408 MHz band. Determination of electromagnetic radiation of the solar flux. The processed results are sent to the Solar Geophysical Data Center. A superheterodyne total flux receiver with a 5 m diameter parabolic radiotelescope is used. The mounting is equatorial with manual operation for the angle of elevation and automatic vertical raising and lowering;

— solar flux-density in the 3 cm band. A 1.87 m diameter parabolic radiotelescope is used with a gain of 35 dB and a main lobe width of 1.2°.

4.3.2 For 1971, it is planned to extend the studies with the following equipment:

— a 606 MHz radiotelescope;
— a 30-600 MHz spectrograph, and
— various polarimeters in the same band for the study of the high solar corona.

5. International relations

5.1 International Telecommunications Satellite Consortium (INTELSAT)

The Argentine Administration regularly attends the meetings of the Committee and more particularly of its Technical Committees.

5.2 International Radio Consultative Committee (CCIR)

An Argentine delegation attended the XII Plenary Assembly in New Delhi. Seventeen contributions were submitted.

5.3 World Administrative Radio Conference for Space Telecommunications (1971)

Thirty papers were submitted for consideration.

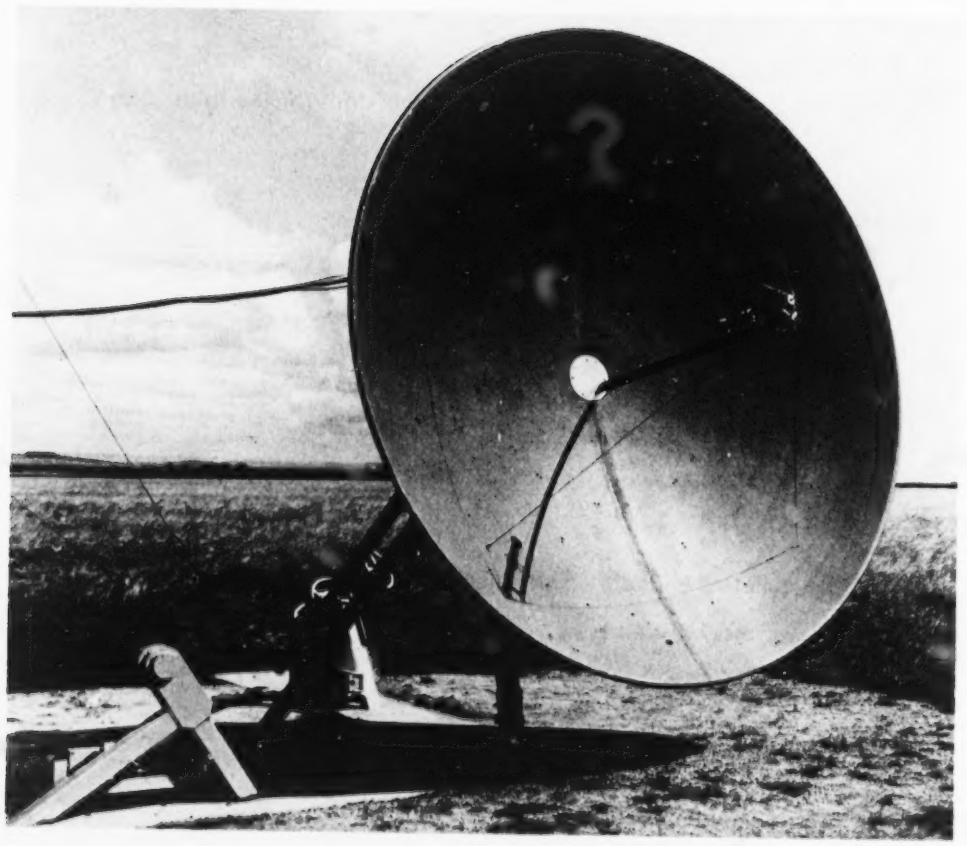
AUSTRALIA (COMMONWEALTH OF)

International communications

In the field of international satellite communications, the year 1970 saw a continued growth in Australia's use of *Intelsat* satellites through the standard earth stations located at Moree, New South Wales, Carnarvon, Western Australia, and Ceduna, South Australia.

At 31 December, 1970, a total of 110 equivalent voice circuits were in use for international telecommunications through the three earth stations of the Overseas Telecommunications Commission (Australia). This compares with a total of 55 equivalent voice circuits in use at the beginning of the year.

Throughout the year, the collocated 13 m earth station at Carnarvon continued to provide, on a full-time basis, tracking telemetry and control services for the *Intelsat* satellite network. Pursuant to a decision by the Interim Communications Satellite Committee (ICSC), this station is now being modified to provide tracking telemetry and control services for the *Intelsat-IV* satellite series.



The 3.65 m diameter outstation

(Australian Post Office)

As a result of a further decision by the ICSC, additional modifications are being carried out to both the 13 m and standard earth stations at Carnarvon to equip them to perform system monitoring functions for the *Intelsat* network. The contract for the provision of this service provides for completion of these modifications by August, 1971.

In addition to this operational involvement in the *Intelsat* system, Australia continued its active participation in INTELSAT management through the representation of the Overseas Telecommunications Commission (Australia) on the ICSC. The Committee met in Sydney during August/September, 1970.

In conjunction with the United Kingdom, the United States and Japan, Australia, during the latter half of 1970, commenced field trials for CCITT telephone signalling system No. 6 on both satellite and composite satellite/cable circuits.

Domestic communications

1. Study and experiments concerning possible subscribers application

A preliminary system study and programme of experiments have been carried out by the Research Laboratories of the Australian Post Office over the last two years. In this time the Laboratories have given special attention to the problems of serving subscribers in remote areas of Australia and evolved a conceptual model of a possible communications-satellite system which might have application to the solution of the problem. Some new and untried techniques are crucial to the technical praticability of the proposal and by arrangement and with the co-operation of NASA it was possible to carry out a programme of experiments using the *ATS-1* satellite which is in orbit over the Pacific Ocean. In addition to the satellite, NASA made available the *ATS* (Applications Technology Satellites) tracking station at Cooby Creek, Queensland, and these were used in conjunction with a small earth station developed and built by the Australian Post Office.

The problem of providing telecommunications service to remote areas of Australia is one for which no universally satisfactory solution has yet emerged. One of the major difficulties is represented by the sheer distances involved but a satellite, which would be accessible from any point in Australia, would overcome this. Consequently a fresh look at the problem seemed to be desirable and a preliminary systems study to take into account the various telecommunications services that remote subscribers might conceivably desire was carried out. The scope of the study encompassed television, facsimile and data services but the major effort was devoted to a subscribers telephony service.

One of the major considerations in the systems study was the need to give due weight to the factors arising because any new service must be integrated into the Australian telecommunications network. Thus, not only was it necessary to consider the satellite and associated earth station terminals, but also methods of setting up and terminating calls and the signalling, switching, numbering and control arrangements possible had to be given attention.

After surveying several possible means of meeting the objectives initially postulated, it was concluded that a suitable network model could be based on a "port" station or stations to give access to and from the existing terrestrial network. A group of subscribers using the satellite could be routed through a port station and the system could expand by forming new groups of subscribers and adding port stations.

The development and introduction of new systems technology into plant use is generally an iterative process starting with a paper study which is added to and modified by experimental work until sufficient data is acquired to allow planning and procurement to proceed. In the case posed by a subscriber service by satellite the initial paper study revealed specific areas of satellite communications technology in which insufficient knowledge was available to allow future system design to be optimized.

The primary objective of the programme of experiments using the *ATS-1* satellite was to obtain the engineering data necessary for later system study and development purposes. In particular, three major items had to be probed over an adequate range of parametric values. The items were:

— channel performance against received signal power level;

— frequency spacing needed between channels to control crosstalk;

— tolerance on outstation transmitter powers for equitable sharing of satellite available power between channels.

After a brief exploratory phase, seven separate experiments to explore detailed aspects of these items were defined and specified. This programme of experiments, using the NASA equipment at Cooby Creek, Queensland, and the *ATS-1* satellite, together with the small experimental prototype earth station developed by the Laboratories, was carried out over the period January to June, 1970. The broad conclusions drawn as a result of this programme were:

— a system of the type proposed is technically feasible;

— the delta modulation scheme tried out fulfilled all expectations and can provide good quality telephone channels;

— the small station has no difficulty in acquiring and holding the satellite despite the absence of complex and expensive automatic servo tracking equipment.

In addition a large amount of engineering data was amassed which is being published in a comprehensive project report. These results are intended for input into the next stage of the overall study of the systems problem which requires data to allow the optimum parameters for an operational system to be defined.

2. Echo cancellation

With the advent of communications-satellites and the rapid growth of international telephone traffic there is a renewed interest in the problem of echoes due to imperfect impedance matching of 2-wire/4-wire transitions in the telephone links.

Conventional means of reducing the intolerable effects of such echoes involve the use of echo suppressors. However, on long telephone links these devices exhibit characteristics which give rise to other objectionable phenomena such as "syllable clipping" and hence other methods of overcoming the problem of echoes are currently being investigated in the Research Laboratories of the Australian Post Office.

Echo cancellation appears to be one of the more fruitful approaches to the problem and has received some attention at a number of research establishments. The method is based on adding to the transmit path of the 2-wire/4-wire transition a signal equal and opposite to the echo, thereby effectively "cancelling" the echo.

In the Research Laboratories the investigation of such cancellers has been in two phases. Phase one was the development of a preset type canceller which required each conversation to be preceded by a short time interval during which the degree of mismatch was sensed and a suitable echo synthesizing network (to cancel the echo) established. The state of cancellation so achieved was then maintained for the duration of the conversation.

Phase two of the project includes the development of an echo canceller capable of achieving the required degree of cancellation using the speech signal itself, i.e. no "set-up" period (as described for phase one above) is required. The principal advantage of this mode of operation over the "preset" type is that any changes in the state of mismatch are immediately accounted for. Further-

more the speed at which the device can adapt to changes in the state of mismatch will make it suitable for use in links containing asynchronous carrier systems.

The successful completion of phase one of the investigation has been reported in the literature [1]. In addition the hardware developed in this phase has been successfully tested in an operational environment. Trials were carried out over the Sydney-Perth satellite link described in Section 3.

The hardware development of phase two [2] is still in progress and is based on all-digital techniques as opposed to the all-analogue approach adopted for the hardware of phase one.

3. Domestic trunk circuits by satellite

Between November, 1969, and the end of July, 1970, 24 trunk circuits were operated between Sydney and Perth (a radial distance of 3300 km) by the *Intelsat-III F4* satellite over the Pacific Ocean. These circuits were established to supplement existing open wire circuits during construction of the Adelaide-Perth broadband microwave system and employed the international earth stations at Moree near the east coast and Carnarvon on the west coast. The connection between Carnarvon and Perth (950 km) was made by recently installed coaxial cable and between Moree and Sydney (575 km) by an existing microwave system. The circuits were controlled on a one-way basis by manual operators at the outgoing end using decadic pulse signalling.

The service had to be opened with the temporary use of *6A* switching-type echo-suppressors (modified to improve their performance on long-delay circuits) and although observations indicated that traffic was passing reasonably well, customer surveys indicated an unsatisfactory level of difficulty. Many of the difficulties described, however, were consistent with the effects of switching-type echo-suppressors. Early in 1970 these echo-suppressors were replaced by modern switching-type echo-suppressors designed for long-delay circuits. Another survey following this substitution reflected a major improvement in customer opinion of the quality of the satellite calls.

In the earlier survey, 56.4% of respondents stated that some difficulty was experienced on their calls, and customers rated 40.2% of their calls as being "fair and poor". After echo-suppressor substitution, only 23% claimed that some difficulty was experienced and it is presumed that these difficulties were

minor, because the ratings of "fair and poor" dropped to 17.8%. Indeed, 82.2% of the calls in the latest survey were rated by the customer as "excellent and good", compared with 56.9% earlier.

Table 1

Inland satellite calls

Comparison of customer reaction before and after modification of echo-suppressor equipment

	customer reaction (callers queried by telephone within one hour of completing an inland satellite call)	
	initial suppressors	improved suppressors
Calls from Sydney to Perth	115 calls	39 calls
— some difficulty experienced	52.9%	33.3%
— no difficulty experienced	47.1%	66.6%
— customer ratings:		
— excellent and good	60.0%	84.6%
— good and fair	69.1%	64.1%
— fair and poor	40.0%	15.4%
Calls from Perth to Sydney	203 calls	191 calls
— some difficulty experienced	58.6%	20.9%
— no difficulty experienced	41.4%	79.1%
— customer ratings:		
— excellent and good	54.7%	81.7%
— good and fair	57.2%	72.8%
— fair and poor	45.3%	18.3%
Calls from Perth and Sydney (bothways)	358 calls	230 calls
— some difficulty experienced	56.4%	23.0%
— no difficulty experienced	43.6%	77.0%
— customer ratings:		
— excellent and good	56.9%	82.2%
— good and fair	62.3%	71.3%
— fair and poor	40.2%	17.8%

In all, the customer reaction survey results showed a reasonable degree of user satisfaction with the quality of the satellite calls. They also point out the desirability of obtaining customer ratings, where practicable, in addition to observer assessments.

Meteorology

The Bureau of Meteorology has continued to operate satellite earth stations at Perth, Darwin and Melbourne to obtain data from meteorological satellites in the *Essa* and *Nimbus* series. All stations now use steerable antennae which are remotely controlled from meteorological offices some miles away, following Darwin's conversion to remote control operation in September, 1970. A further remotely controlled earth station will be provided for Brisbane during 1971 to extend coverage to the north and east of Australia. A fixed antenna receiving system in Melbourne receives daily satellite facsimile data from the United States via the *ATS-1* synchronous satellite.

A portable APT station has been provided to support Australia's Antarctic expedition in the 1970/71 summer. The equipment will be installed at Mawson to provide satellite pictures which will assist forecasting during geophysical surveys.

Co-operation in other space projects

During 1970, operations continued in support of manned space flights, deep space probes and earth orbital scientific or applications satellites.

In April, 1970, Carnarvon, Honeysuckle Creek and Tidbinbilla stations participated in the *Apollo-XIII* flight. When problems arose during the mission the 64 m radio telescope at Parkes was called up at short notice and played a key role in maintaining communication with the spacecraft.

Use of the *ATS* station at Cooby Creek for Australian experiments ceased in June, 1970, and the station has been returned to the United States. Construction of the new deep space 64 m advanced antenna system at Tidbinbilla has continued.

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[1] Bruggemann, Kidd, Mackechnic, Seyler: "Experiments on adaptive echo cancellation" —*A.T.R.*, Vol. 4, No. *1*, May, 1970

[2] Mackechnic L. K.: "Continuously adaptive echo cancellation"—*Electronics Letters*, Vol. 6, No. *3*, February, 1970

BRAZIL

General

During 1970, Brazil, through *Emprêsa Brasileira de Telecomunicações* (EMBRATEL), has continued to expand its services via satellite by utilizing the *Intelsat* space segment, as well as taking active part in the INTELSAT Committees and Sub-Committees.

Installations

The necessary equipment to receive the French carrier to South America via the *Intelsat-III F6* satellite, was procured and installed, and direct service with France was initiated on 5 September 1970.

View of the Brazilian earth station at Tanguá

4.6.

With the introduction of this carrier, Tanguá earth station is now receiving a total of 10 carriers taking into account the service with Colombia which started on 30 March, 1970.

In order to be capable of operating with the *Intelsat-IV* satellite, EMBRATEL has already procured equipment for:

a) two exciter chains for a new carrier of 60 channels;

b) CGE equipment to modify the existing equipment, in order to operate with the *Intelsat-IV* transmission parameters;

c) multiplex equipment both for Tanguá and for the international switching centre located in Rio de Janeiro.

Utilization of the facilities

The number of voice grade circuits in operation on 31 December 1970 was 73 as compared to 49 circuits in operation on 31 December 1969. These circuits were distributed as follows:

country	voice circuits for telephony use	voice circuits for record use	total
Argentina	8	1	9
Canada	2	—	2
United States	22	6	28
Colombia	1	—	1
Chile	2	—	2
France	5	1	6
Germany	5	2	7
Switzerland	2	—	2
United Kingdom	2	1	3
Italy	5	2	7
Japan	1	—	1
Mexico	1	—	1
Peru	1	—	1
Portugal	1	—	1
Spain	2	—	2
total	60	13	73

Operating services

The phototelegraphy service via EMBRATEL was initiated during the Soccer World Cup in Mexico, in May 1970.

A demonstration of data transmission between Brazil and Italy was performed during October 1970 at a velocity of 1200 bits/s.

The existing services of telephony, telex and telegraphy showed a sharp increase in the utilization of the facilities.

In finishing this short report on past activities, we would like to mention the plans of EMBRATEL for the near future:

— by February 1971, we expect to have in operation our semi-automatic international telephone exchange, and in the middle of 1971 our automatic international telex exchange.

EMBRATEL is also preparing a specification of a telegraphic message switching centre for Brazil, to be in operation in three years' time.

CAMEROON (FEDERAL REPUBLIC OF)

In 1970 the Federal Republic of Cameroon carried out an overall survey on the installation of a communication-satellite earth station at Yaoundé. The site of the station was selected and borings made. Specifications were drawn up and an invitation for tenders was issued in May; the bids were examined in August and construction work will begin shortly.

The earth station is scheduled to come into service at the beginning of 1972 and it will then be possible to initiate technical and scientific studies on space communication in Cameroon.

CANADA

1. International satellite communications

1.1 A fully commercial satellite communication earth station at Mill Village, Nova Scotia, was completed by the Canadian Overseas Telecommunication Corporation (COTC) in February, 1969 and has been providing commercial service with European administrations via the *Intelsat-III* satellite positioned over the Atlantic. A description of the station's characteristics and operational capability is contained in the Ninth Report by the ITU on Telecommunication and the Peaceful Uses of Outer Space.

As an active member of INTELSAT the COTC participates in the continuous development of improved systems for commercial satellite communications. Modification and enlargement of the Mill Village station's communication facilities is now under way and will afford an increased operational capability in both global and spot beams of the *Intelsat-IV* Atlantic Ocean satellite in 1971. The COTC also plans construction of a communication satellite earth station at Lake Cowichan on Vancouver Island, British Columbia, which is tentatively scheduled to commence operation via the *Intelsat-IV* Pacific Ocean satellite n mid-1972.

2. Domestic satellite communications

2.1 The basic characteristics of Canada's planned domestic communication satellite system are described in the Ninth Report.

Progress towards the development of the system continued rapidly during 1970. In September, a contract was signed with the Hughes Aircraft Company of the United States for the design and construction of the satellite. Major sub-contractors include two Canadian companies: Northern Electric will supply the entire electronics package for the first series of Canadian satellites including production, integration and testing of the communications sub-systems, telemetry and command, antenna de-spin electronics, power electronics, batteries and harness. Northern Electric will also assemble and test the ground control electronics used in the telemetry telecommand and control station. The construction of the satellite structure has been undertaken by Spar Aerospace Products Limited.

The major characteristics of the satellite are as follows:

— transfer orbit weight	550 kg approximately
— number of RF channels	12
— e.i.r.p. per RF channel	33 dBW minimum
— transmit frequency	3.7-4.2 GHz
— receive frequency	5.925-6.425 GHz
— saturating flux-density	-80 dBW/m^2
— RF channel bandwidth	36 MHz
— antenna coverage	single beam—all of Canada
— design life	7 years
— orbit inclination control	$\pm$ 0.1°
— longitudinal drift control	+ 0.1°

In addition to the several classes of planned earth stations which were described in last year's report, plans are also under way to develop a low-cost thin route

communication system for the north, suitable for 1-6 voice circuits and the reception of radio programmes. The current design is for earth stations with a G/T of 20 dB (5 m diameter antennae). Several modulation and multiple-access systems are being evaluated including PCM/PSK and analogue FM single voice channel per carrier systems. A final design is expected during 1971.

3. Research and development

3.1 UHF propagation studies

The Communications Research Centre (CRC) has been involved in a co-operative programme to investigate the properties of UHF satellite systems at frequencies near 300 MHz since July 1967. One of the main objectives of the programme has been the investigation of the propagation environment as it affects satellite communications system performance at UHF. An extensive series of measurements of signals received from satellites having UHF beacons has been performed at various Canadian locations including Ottawa, Churchill and Resolute Bay.

The programme has included measurements of ionospheric fading, time dispersion, and frequency selective fading during various ionospheric conditions including visual aurora.

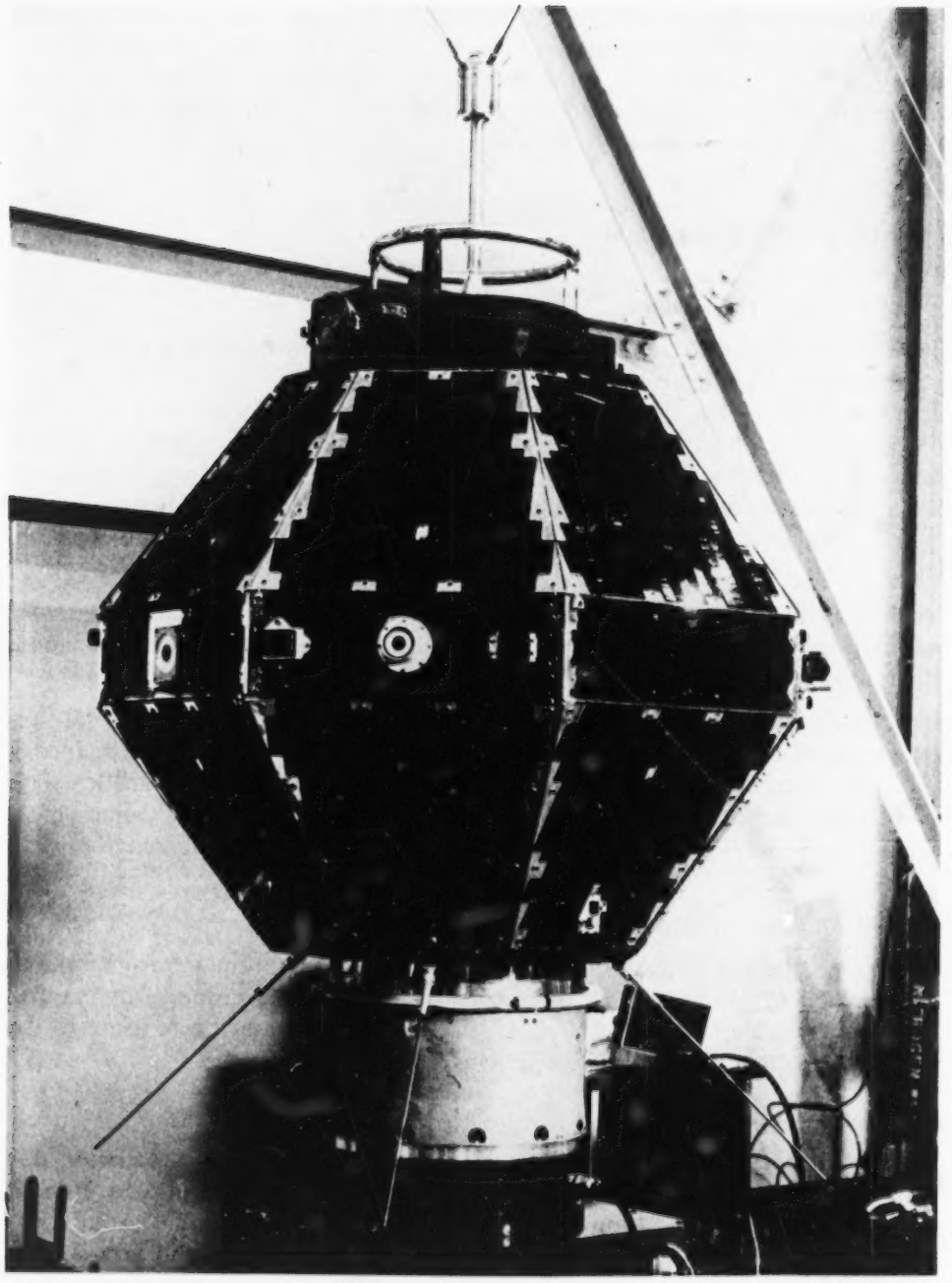
Simultaneous measurements of ionospheric fading of satellite signals, at frequencies near 136, 250 and 1550 MHz have been in progress at CRC since January 1970. The major objectives of this programme are to accumulate statistical data on the frequency dependence of fading amplitude to permit satellite communications systems margins to be specified accurately in the VHF/UHF range.

3.2 SHF propagation studies

The CRC of the Department of Communications has a continuing programme to study the effect of the earth's atmosphere on radiowave propagation, at frequencies between about 4 and 30 GHz, particularly as these effects relate to the design of satellite communications systems.

■ *Precipitation attenuation*

The CRC programme is primarily concerned with the study of attenuation due to precipitation. Given the drop-size distribution and the distribution of rainfall intensity along the propagation path, a reasonable theoretical estimate of attenuation can be made. However, little is known of the distribution in time and in space of these meteorological parameters nor of the variation of the statistics of occurrence of attenuation due to rainfall with location and elevation angle as required by the systems designer.



Isis-B *satellite* (Department of Communications, Ottawa)

On the basis of data obtained from aircraft experiments which CRC conducted during 1967 and 1968*, it was concluded that radar can be used to calculate values of path attenuation that give satisfactory agreement with the observed values, provided that hail or a melting layer is not intercepted by the radar beam. If these conditions exist, the attenuation calculated from the radar data can be greatly in excess of that observed.

Since September 1969, CRC has been carrying out precipitation attenuation measurements using the 15.3 GHz beacon on the NASA *ATS-5* satellite. The beacon signal is received on a 10 m antenna and the transmission loss data obtained provide a direct measure of precipitation attenuation. The 10 m antenna is also fitted with a 15.3 GHz radiometer for simultaneous measurement of atmospheric emission temperature. An estimate of attenuation can be obtained from the sky noise temperature measurement. A second 15.3 GHz radiometer, on a 2.6 m antenna, is located about 4.5 km from the main 10 m terminal.

The 2.9 GHz weather radar is used to obtain backscatter data along the propagation path in the direction of the satellite. The radar is also used in a scanning mode to provide information on predicted attenuation in other directions and a measure of storm cell size.

Considerable work has been done in comparing attenuations predicted from the radar and radiometer with those measured directly using the *ATS-5* beacon. Generally good agreement has been obtained with the data analyzed to date, although a situation during which hail or a melting layer has been present has not yet been examined.

In order to obtain long-term statistics on precipitation attenuation for small percentages of any year as a function of elevation angle, it is planned to operate continuously radiometers at three different elevation angles at a frequency near 13 GHz.

■ *16 GHz long-range tropospheric scatter*

CRC is also involved in a co-operative programme to study tropospheric scatter propagation over a 500 km path between Boston, Massachusetts, and Ottawa, Ontario, at 16 GHz. The transmitter, located near Boston, provides 2 kW and uses a 9.6 m antenna. The receiver, located at CRC, uses a 10 m antenna. The purpose of the experiment is to utilize the common volume intersection of the narrow (approximately 0.15°) beam antennae as a remote probe of the tropo-

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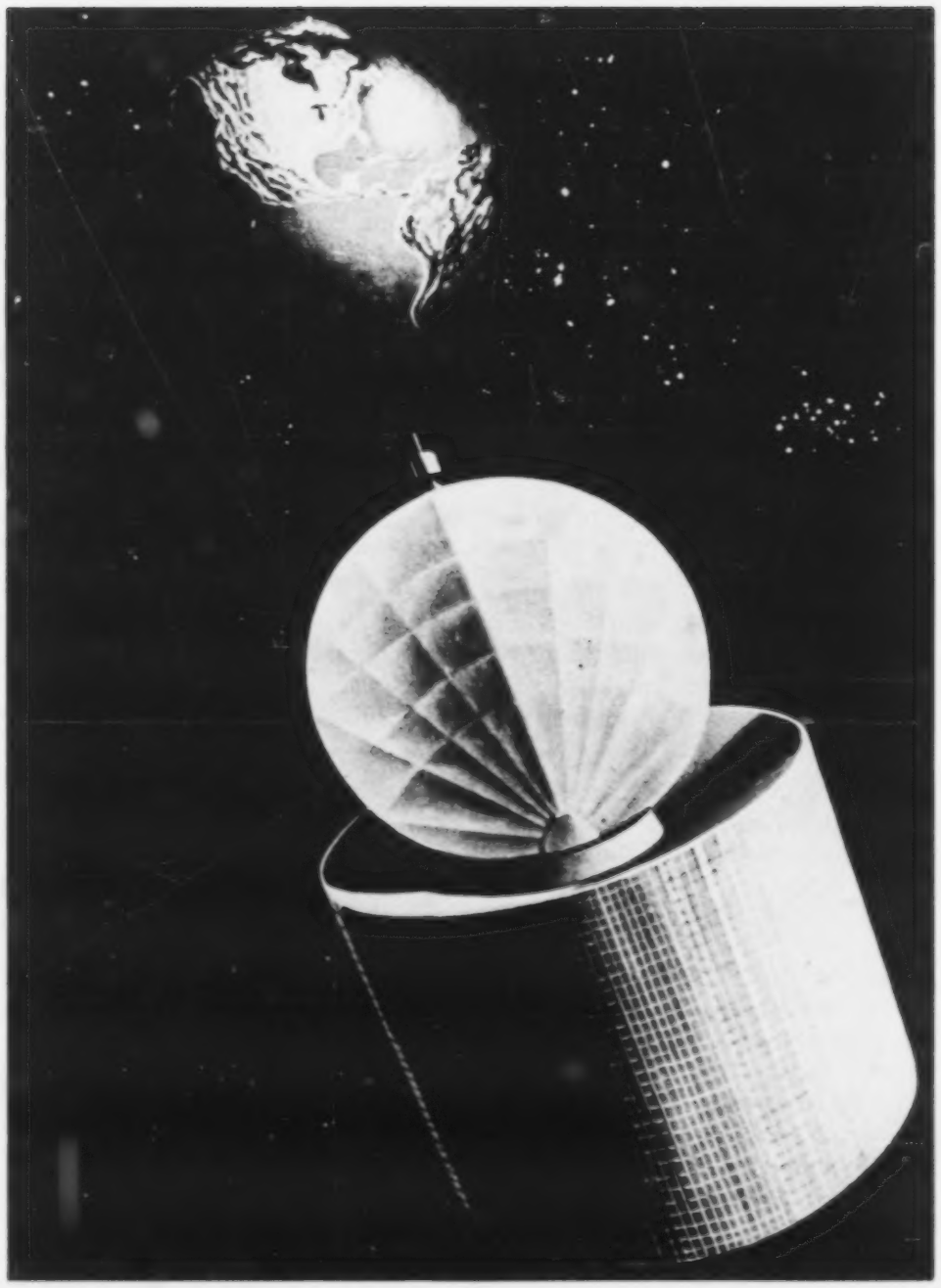
* These experiments were designed to measure precipitation attenuation using aircraft borne beacon transmitters at 4, 8 and 15 GHz. In addition, a weather radar at 2.9 GHz was used to obtain radar backscatter measurements from precipitation along the propagation path.



Artist's impression of Anik-I, *the Canadian domestic communication satellite*

sphere. The data gathered may also be of value in investigating interference problems between satellite communication and terrestrial systems.

The two antennae are synchronously scanned so that the beam intersection follows a predicted path in space. In this way, information is obtained on spatial characteristics of the scattering medium. Doppler frequency measurements provide information on wind motions.

■ *Low-angle tropospheric scintillation*

Signal amplitude fading results when SHF signals are propagated through the troposphere. The depth of fading is dependent on the length of the path in the troposphere and, hence, on the elevation angle of a satellite communication circuit. A peak-to-peak fading amplitude of 2 dB is typical for 5° elevation at 7 GHz. Amplitude fading statistics are important for system designers who must make allowances for propagation margins.

A continuing series of measurements of low-angle tropospheric fading is now being carried out by CRC employing a fixed 10 m ground terminal and a transportable 2 m ground terminal. Several aspects of tropospheric fading are being investigated and include the frequency dependence and spatial coherence of fading, and its variation with latitude and time.

3.3 Upper atmosphere research

Alouette-I, launched in September 1962, after more than eight years of operation, now supplies about 30 minutes of useful ionospheric data each day. *Alouette-II*, launched in November 1965, supplies 3 to 5 hours of data each day. *Isis-I*, launched in January 1969, is operating 6 to 8 hours each day.

The *Isis-I* satellite is proving to be very useful as an ionospheric observatory since it permits the measurements of energetic particle fluxes, ion composition, and ion and electron density and temperature, simultaneously with the top side sounder measurements. For example, one particular study which is in progress is a study of the generation of radio noise by low energy particles, which are observed by *Isis-I*, and of the effect of these particles and the plasma temperature on the structure of the ionosphere.

The construction of *Isis-B* is complete and launch of the satellite for upper atmosphere exploration is planned for early 1971 from Western Test Range of Kennedy Space Flight Center. RCA Limited is carrying out all work of systems engineering, integration and test of the satellite, including integration and test of the power, telemetry and command, and data storage equipments, as well as the development, fabrication and integration of two photometric experiments to investigate the red and green emissions from auroral and air glow. In addition, *Isis-B* contains instruments similar to those on *Isis-I*.

3.4 Low-capacity communications to remote areas

Canadian conditions demand particular attention to this problem. The low economic base of the isolated communities and the physical restrictions on mobile operations make satellite communication systems with very simple ground terminals desirable. There has been considerable study by the CRC of the choice of frequency band, the impact of frequency sharing criteria and the choice of processing and modulation techniques for voice communications with a single voice channel per RF carrier. Since the communications requirements of each terminal will be intermittent, it is desirable to find methods for sharing the satellite channels among many ground terminals. Frequencies of the order of 1500 MHz are considered to be particularly suitable for this type of satellite system. A centrally controlled channel assignment system has been designed. It has been found that analogue FM with companding and pre-emphasis of the speech signal requires the least signal power per carrier from the satellite transponder. Consideration of the effect of adjacent interference and transponder cross-modulation products may avour digital PCM or deltamodulation techniques but this has not been fully nvestigated.

3.5 Aeronautical

In order to obtain information on the propagation characteristics of VHF and UHF (L band) at northern latitudes, as part of their continuing work on the application of space techniques relating to aviation the Telecommunications and Electronics Branch of the Department of Transport has undertaken to perform a series of propagation measurements at 1550 MHz using the satellite *ATS-5* and at 250 MHz using the satellite *LES-6*. These measurements will be done at Churchill, Manitoba, starting March 1971.

3.6 Meteorological

The Meteorological Branch of the Department of Transport through its facilities at the Toronto international airport, directly receives, evaluates, studies and applies data acquired directly from United States meteorological spacecraft. Routine daily receptions are applied to real-time meteorological uses, while archived data is provided for research and other studies relating to surface or environmental conditions.

Over the past year, transmissions have been acquired from the polar orbiting *TOS* (*Tiros* Operational Satellite) spacecraft, *Essa-8*, *Nimbus-III*, an experimental meteorological spacecraft, and in addition some scheduled APT re-transmissions from *ATS-I* and *ATS-III* have also been monitored. Transmissions of the recently launche *Itos-1* satellite have been evaluated in both APT and infrared (IR) modes, and studies of the received IR data using densitometer techniques are in progress.

The Meteorological Service plans for acquiring APT type data at east and west coast stations have been temporarily delayed. However, it is still intended to establish a network for acquiring and distributing real-time or near real-time satellite data to forecast centres.

3.7 Other developments

Bell-Northern Research, Ottawa, Ontario, formerly Northern Electric Laboratories, has undertaken a number of continuing programmes in the field of domestic and international space telecommunications. Some of these new developments contributing to progress in space radiocommunications, are outlined below:

■ *Parametric amplifier*

To enhance the reliability and performance of communications satellite ground stations, a parametric amplifier which operates at room temperature has been developed. Featuring a 500 MHz bandwidth in the 3.7 to 4.2 GHz range, the fully solid state amplifier is believed to be a world leader. Low noise performance has been further improved to 100°K with a gain of 30 dB through a three-stage cascaded paramp. It achieves this performance without the use of multiple-tuned broadbanding circuits which, together with its simple straightforward design, enhances the system availability and complies well with the unattended operation philosophy of modern earth stations.

■ *Wideband FM demodulator*

Another development for multi-channel or television receive-only earth stations, the wideband FM demodulator will go into service in North America in 1971 and has aroused widespread interest for communications satellite systems. The demodulator avoids the inherent bandwidth limitations of tuned networks by using a pulse-integration technique which converts the frequency modulated carrier into pulses which it subsequently integrates to produce a baseband signal. The high linearity thus obtained is equivalent to very low noise contribution. State of the art thick-film techniques are now being applied to the demodulator to improve further reliability and reduce the size of the package. The demodulator has also found application in the new 100% solid state *RA-3* terrestrial microwave radio family of systems.

■ *Common waveguide multiplexer*

This recently-announced multiplexer uses a new technique to simplify construction and tuning while also reducing the overall weight and size of complex microwave components used in the transponder portion of communications satellites. The heart of the new 3.7 to 4.2 GHz multiplexer design is a complex filter which is a combination bandpass and bandstop design. The complex filter portion of the multiplexer is extremely versatile since the component blocks can be tuned inde-

pendently and physically separated without affecting their electrical performance. This latter feature provides mechanical flexibility in the design and layout of the communication platform of the spacecraft.

Although developed primarily for satellite transponder use, the new technique can be used in all systems where bandpass filters are required and will find application in heavy route satellite earth stations where one common antenna is used for more than one transmitting channel.

■ *Duplexer polarizer*

A recently developed duplexer polarizer for earth station antennae has been supplied for pilot programme use for proposed domestic satellite systems. The polarizer forms part of the earth station antenna and performs the function of combining and separating transmitters and receivers.

■ *Systems engineering*

Continuing systems engineering studies related to aerospace communications are exploring such questions as the integration of satellite facilities into the Canadian telecommunications network, the achievable performance of international systems and satellite systems for developing countries. In addition, studies are now in progress on communications by satellite to the far north and digital communications by satellite.

Another Canadian company, RCA Limited (Space Systems), has made a number of significant contributions to progress in space radio communications during 1970. Among these contributions were: the completion of systems design of a medium capacity satellite which could operate in the 4-6 GHz bands and provide up to 12 television channels of coverage and which could be used by domestic satellite communications systems. Development for the system included special spacecraft microwave filters, and a special lightweight and rugged antenna having special transmit and receive beam shaping characteristics; the design and test of precision 70 MHz IF bandpass filter modules to limit transmitted deviation so as to prevent adjacent channel interference occurring in the *Intelsat-IV* satellite; the design and test of an economical 10 m antenna and feed system for application to unattended satellite earth stations in remote locations; the refinement of the design of the RCA single horn multimode feed system for operation in the 4-6 GHz band to improve performance and simplify fabrication and test.

This work covered primarily the design of the centre section of the feed system carrying the communications signal. G/T performance at 4 GHz band edges was markedly improved.

RCA also designed and developed a computer-based automatic test system for rapid check of performance of a spacecraft while undergoing pre-launch tests. Checks were made against pre-programmed limits for each parameter to be measured. The output data may be stored for later processing, or displayed in real

51

time on analogue or digital displays. A digital real time television display was used with facility for production of hard copy microfilm prints. The display system replaced the high speed in-line photo optical printer normally used in computer-based test sets. Data read-out proved to be orders of magnitude faster than other spacecraft test systems and the volume of data with the microfilm prints an order of magnitude less.

Spar Aerospace Products Limited has been engaged in the basic spacecraft layout and design of the attitude control power generation and long deployable solar cell panels which could be used in a communications technology satellite. This company is also engaged in the design of a solar cell array system, and is supplying stem antennae and gravity gradient stabilization booms for spacecraft on programmes of several other countries.

CEYLON

Ceylon is seriously considering the construction of a communication-satellite earth station. Preliminary studies on feasibility etc. have been made but no firm decision has yet been taken as regards the date of implementation of the project.

CHINA

The Taipei earth station, which started its service in December 1969, operated very successfully throughout 1970. The average performance reliability stood at 99.8%. Overall telephone traffic in the Pacific region registered an increase of 75% as compared with 1969. In addition, 54 television programmes (52 receiving and 2 transmission) totalling 1893 minutes were handled in the year. By the end of 1970, 41 satellite circuits were in operation. A transfer plan for transition of service from *Intelsat-III* to *Intelsat-IV* has been finalized.

In view of the most encouraging results of the first earth station and coping with rapid economic development in the Republic of China, the government has approved another project to build a second earth station for Indian Ocean satellite communication. The Spade system will be provided for the new earth station which is scheduled for completion and operation in early 1973.

CONGO (DEMOCRATIC REPUBLIC OF THE)

The Democratic Republic of the Congo is in the process of installing an earth station.

CUBA

On 8 January 1970, the Revolutionary Government of Cuba signed an agreement with the USSR for the installation in Cuba of an earth station for satellite communications which will be used for telephone, telegraph and multichannel communications and for the exchange of radio and television programmes.

Construction of this station will begin in 1971 together with the training of the Cuban staff to operate it.

DENMARK, FINLAND, NORWAY AND SWEDEN

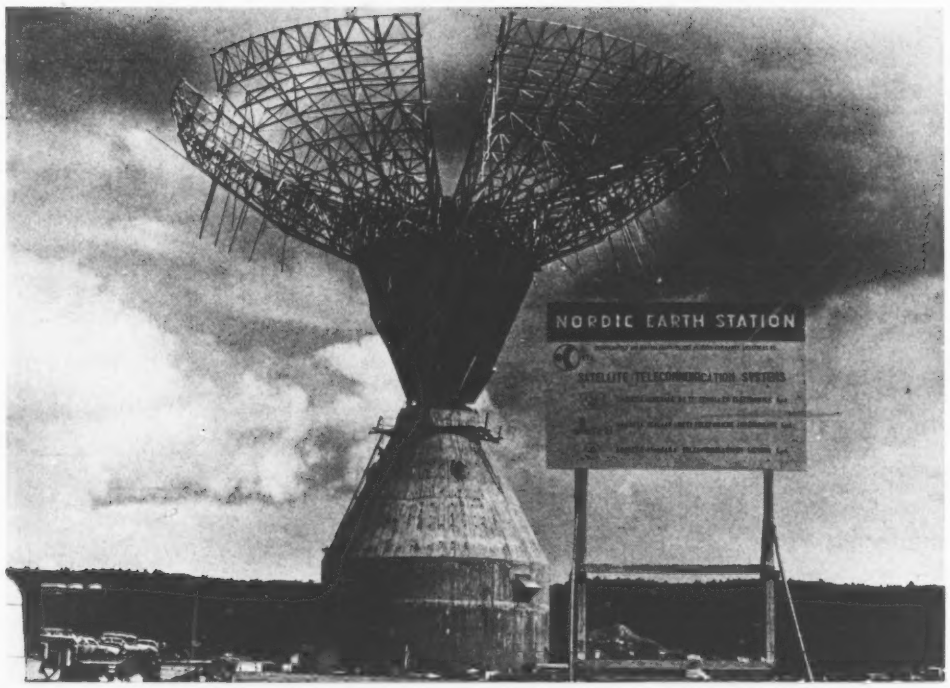
The common Nordic earth station which, as mentioned in the Ninth Report, is to be established at Tanum on the west coast of Sweden pursuant to an agreement concluded between the Telecommunications Administrations of Denmark, Finland, Norway and Sweden, is at present under construction. The station is intended for communication over the Atlantic via satellites of the *Intelsat* system.

The station will primarily be used for exchange of telephone, telegraph and data traffic with the United States and Canada via the *Intelsat-IV* satellites, but it will also be equipped for transmission and reception of television programmes. In addition, it will later on be equipped with a demand assignment system (Spade) for exchange of traffic with a large number of countries in South America, Africa and the Middle East.

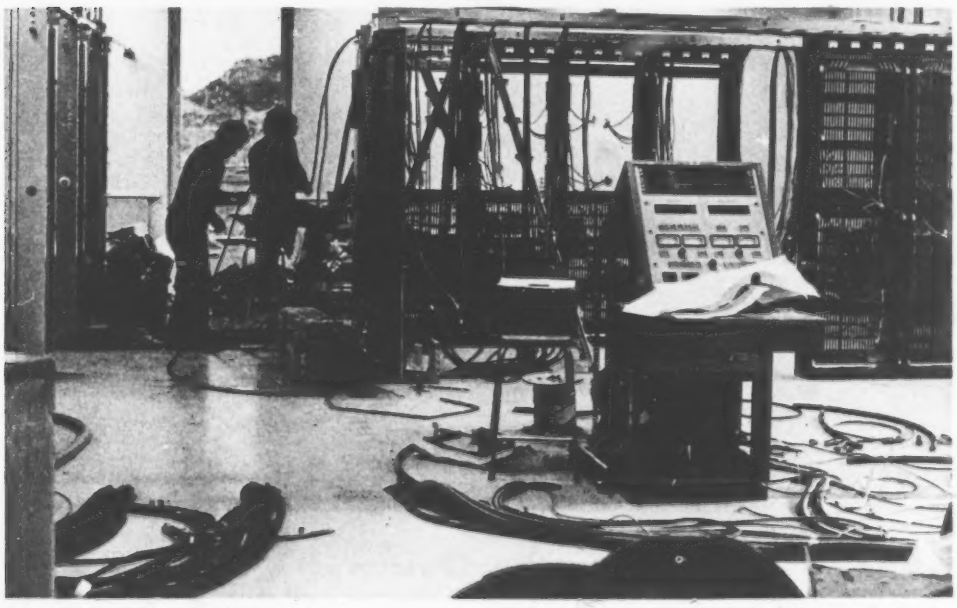
The station will have an antenna measuring about 30 m in diameter. The antenna system and other electronic equipment have been ordered from an Italian consortium, *Consorzio per Sistemi di Telecomunicazioni via Satelliti*, Milan. Other technical equipment, such as power installation, as well as buildings are delivered by companies in the Nordic countries.

The installation of the radio-technical equipment is expected to be finished in May 1971. The lining-up of the station will probably begin in the autumn of 1971, and the station is scheduled to become operational during the last quarter of 1971.

The Tanum station will be operated by the Swedish Administration on behalf of the four Nordic countries concerned, whereas the operating personnel required may be recruited from all four countries. All important decisions concerning the earth station are taken by a board composed of representatives of the four Nordic Administrations.



View of the Nordic earth station under construction at Tanum, Sweden



(Televerkets Centralförvaltning)

The Tanum earth station during installation

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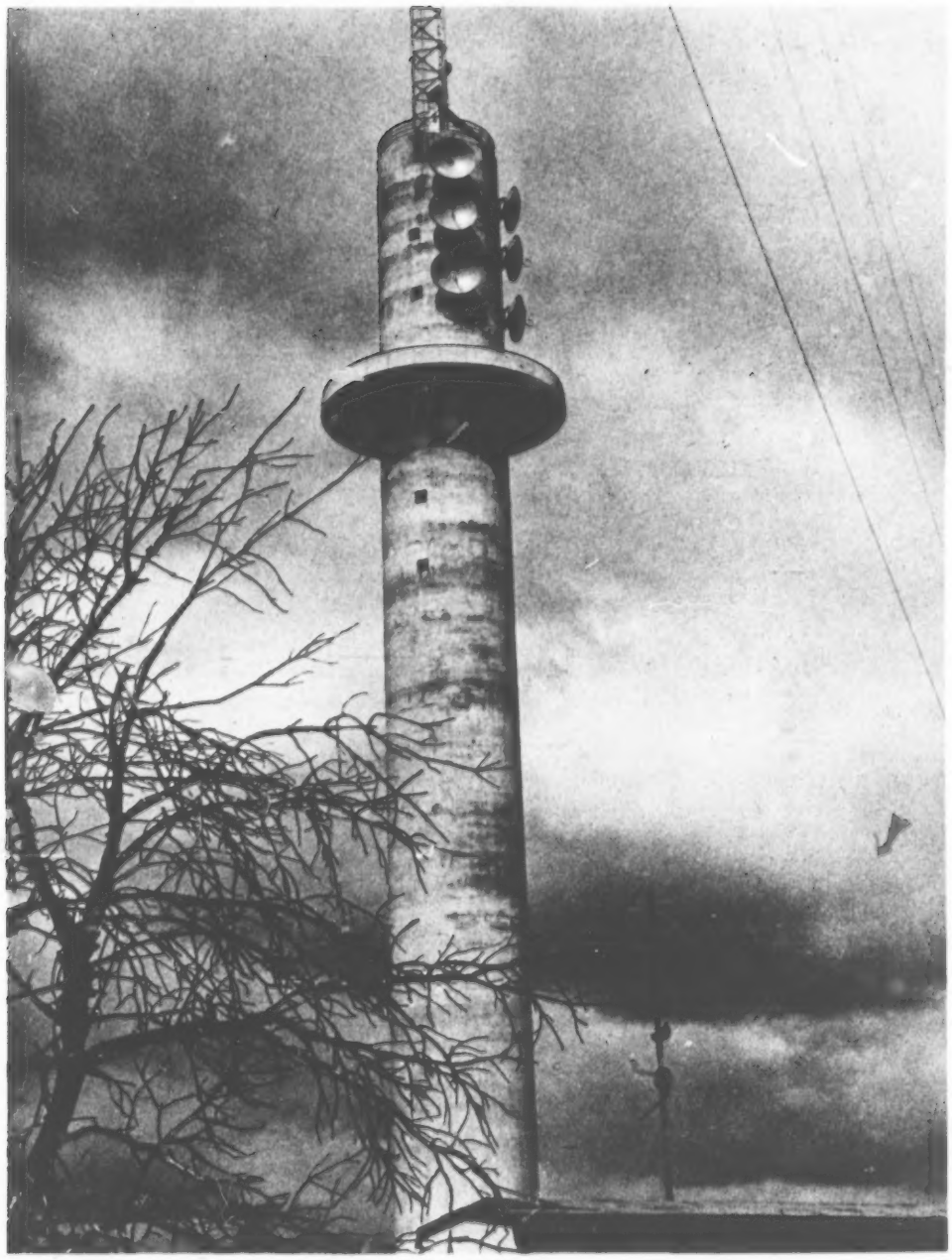


The Brudaremossen radio-link tower (Göteborg) which is part of the network linking the Tanum earth station with the other Nordic countries

(Televerkets Centralförvaltning)

SPAIN

Buitrago II earth station

The Buitrago II earth station for satellite communications was officially opened on 13 April 1970. This station, which is owned and operated by the *Compañía Telefónica Nacional de España* works with the Indian Ocean satellite *Intelsat-III* and at present has direct links with stations in Australia, Indonesia, Japan, Kenya and Kuwait; it is hoped in the near future to increase the number of link-ups by establishing direct communication with the Philippines, Hong Kong, India, Lebanon, Pakistan and Thailand.

The station also provides transit circuits for countries which have no direct access to the area in question: i.e., with the United States of America at present and, in the future, Canada and the Latin American countries.

Technically the station belongs to the so-called "standard" group and has already been officially approved for access to satellites of the *Intelsat-III* series by the INTELSAT Interim Committee. Its principal characteristics are:

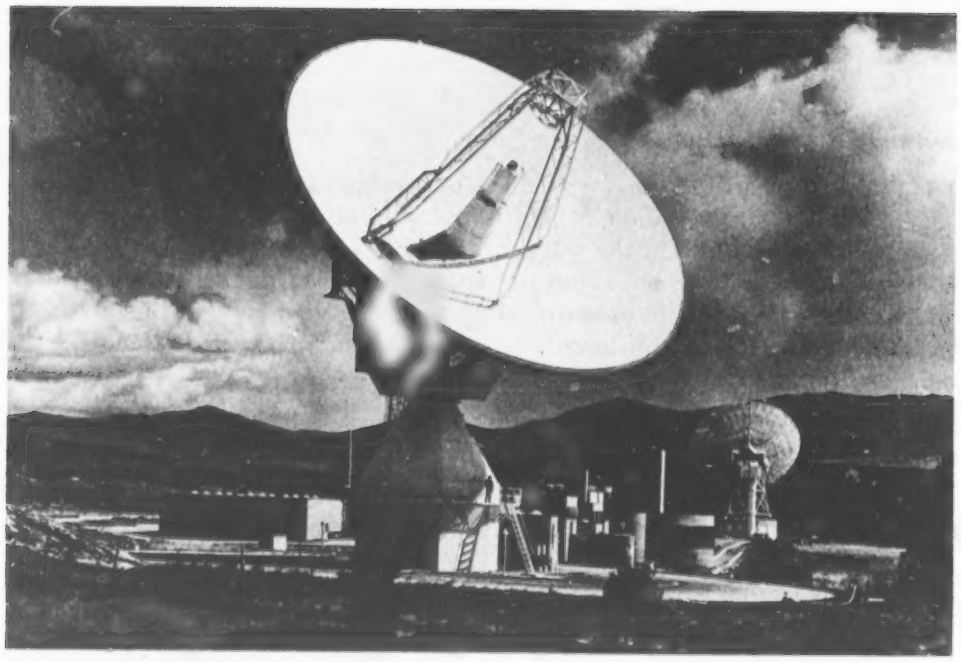
— range of working frequencies	5925-6425 MHz (transmission) 3700-4200 MHz (reception)
— antenna diameter	30 m
— figure of merit (G/T)	41.5 at 4 GHz
— capacity	
— transmission	1 message channel + vision + sound (duplicate equipment)
— reception	12 message channels + vision + sound 2 message channels (reserve equipment)

Agüimes (Canary Islands) earth station

In line with its policy of expanding its intercontinental links, the *Compañía Telefónica Nacional de España* will inaugurate its third "standard" earth station in April 1971 at Agüimes in the Canary Islands, which will work with the Atlantic Ocean *Intelsat-IV* satellite. Its function will be to relay the international traffic originating in the Canary Islands, to assist the Buitrago I and II earth stations in case of damage or for effecting satellite-to-satellite transfers and to effect direct television transmissions between Spain and the Canary Islands.

The principal technical characteristics of the new station are:

— range of working frequencies	5925-6425 MHz (transmission) 3700-4200 MHz (reception)



The Buitrago (Spain) earth station. In the foreground, antenna I provides telephone communications with North America and various South American countries; in the centre, the control room; in the background, antenna II

(Estudios Pancho, Madrid)

— antenna diameter 30 m
— figure of merit (G/T) 41.5 at 4 GHz
— capacity

a) simultaneous transmission of 5 carriers (which may be increased to 8) for messages and 2 carriers for television transmissions (video and sound);

b) simultaneous reception of 16 carriers for messages and 2 carriers for television reception.

UNITED STATES OF AMERICA

1. Satellite systems and services

1.1 Meteorological satellite

The first of the series of Improved *Tiros* Operational Satellites *(Itos)* was launched in 1970. This spacecraft combines stored data and direct readout Automatic Picture Transmission (APT) capability in a single satellite. *Itos-1*, launched

5.7

23 January 1970, was placed in operational service on 15 June 1970. Since then it has been supplying world-wide stored picture data, direct readout APT during the daylight portion of its orbits and scanning radiometer data during the night-time portion. *Essa-2*, the first automatic picture transmission satellite of the system, was deactivated on 16 October 1970, after providing useful cloud photography for over 4½ years. *Essa-8*, another APT-type spacecraft, is providing pictures to meteorologists throughout the world. About 500 APT stations located in nearly 60 countries were established to receive this information. This is the fourth consecutive year that daily world-wide pictorial coverage of the earth and its cloud systems has been furnished by *Essa* satellites.

During 1970 the meteorological satellites provided more than 70 000 usable pictures resulting in identification and tracking of 40 hurricanes and typhoons. This information contributed significantly to the accuracy and timeliness of information provided by the world-wide meteorological services.

ATS-I and *ATS-III*, launched on 6 December 1966 and 5 November 1967, respectively, continued to furnish extremely valuable data for research and operational experiments. The long useful lifetime of the spin scan cloud cameras and of the transmitters on these spacecraft has demonstrated the potential of geostationary satellites for routine operational observation of the environment. The operational version of these spacecraft will be the Geostationary Operational Environmental Satellite *(Goes)* now being developed. The prototype of these spacecraft is planned for launching in 1972.

Time-lapse films, made from *ATS-I* and *III* spin scan cloud camera pictures taken at 15 or 30-minute intervals, were used in near real time as an aid to forecasting the development and movement of active hurricanes.

Wind information is derived from daily film loops of *ATS-I* and *III* pictures and is used as input to the numerical analysis programmes of the National Meteorological Center. Satellite pictures, picture mosaics and specialized charts were transmitted through the *ATS-I* and *III* spacecraft to APT stations within communications range of the spacecraft as the WEFAX (Weather Facsimile Operational Experiment) programme.

1.2 United States Government Communications

Six advanced geostationary satellites are being procured to form the space portion of the second generation United States Government communications-satellite system. This will replace the initial system that used 23 near-synchronous drifting satellites. Each new satellite, operating in the 7250 to 8400 MHz frequency band, will contain two narrow beam antennae (approximately 2.5° beamwidth) and one earth coverage antenna. Use of recent technological developments has allowed a large increase in channel capacity. New earth station terminals are being developed that will allow full use of the increased capacity and correspondingly wider bandwidth.

1.3 Commercial communication system

A resumed Plenipotentiary Conference was held in Washington, DC, in February 1970, which established an Intersessional Working Group (IWG) to negotiate a single set of recommended texts of Definitive Arrangements for INTELSAT. The IWG held three meetings in 1970 and is expected to issue its report to a reconvened Conference in April-May 1971.

Three *Intelsat-III* satellites were launched in 1970. The new satellites provided a significant increase in the number of channels available for use in the system. The traffic increase in 1970, as compared to 1969, is reflected in the following statistics: the number of full-time units (one unit is basically a two-way voice-grade link between an earth station and a satellite) in service on 31 December 1969, was about 3000; on 31 October 1970, it was just under 4000. In the twelve months of 1969, INTELSAT carried 763 transmit hours of television; 835 transmit hours were carried during the first ten months of 1970. Since many of the television transmissions were to multiple earth stations simultaneously, the number of receive hours was much higher; 1063 in 1969 and 1225 in the first ten months of 1970.

INTELSAT reduced by 25% the per annum full-time leasing costs to be effective 1 January 1971. This is expected to stimulate interest and result in an increased amount of traffic carried in 1971.

The United States brought into service earth stations in Alaska and Guam and now has 9 antennae at 8 earth stations carrying commercial traffic. On 30 November 1970, 29 of the 77 Member countries of INTELSAT had 51 antennae at 43 earth stations available for carrying commercial traffic.

1.4 Amateur radio service satellites

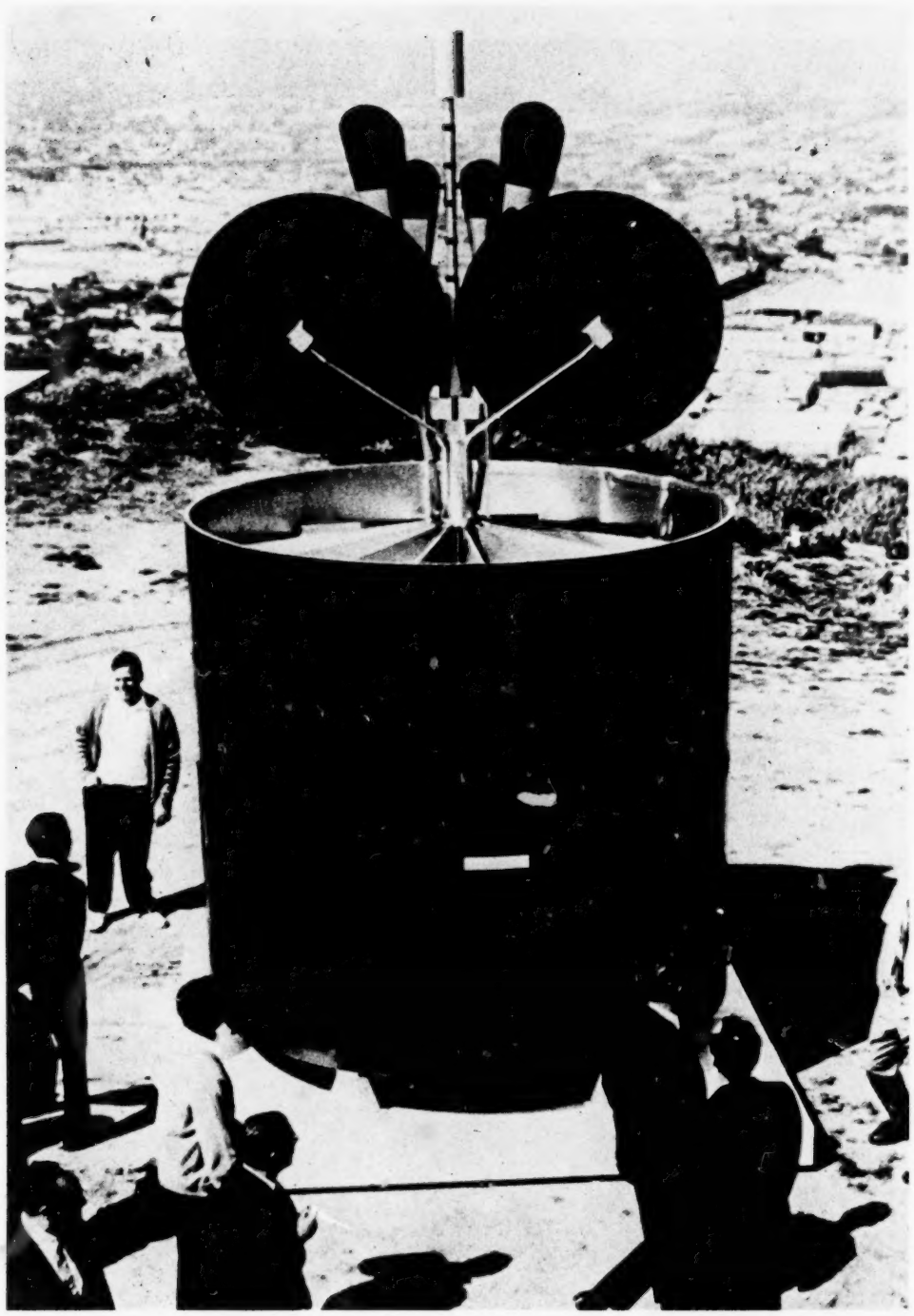
On 23 January 1970, an Australian-designed and built amateur radio satellite was launched as a secondary payload, on a *Thor-Delta* launch mission, by NASA. An international group of amateurs arranged for the launch and co-ordinated world-wide tracking and reception analysis. Called the *AO-5 (Australis-Oscar-5)*, the mission provided the opportunity to test several important concepts in the satellite amateur service which included:

a) the first ground command-controlled amateur satellite. This negates the need for absolute power flux density limitations in the amateur service as any interference to other services can be controlled on command;

b) the first satellite to operate in an HF amateur band;

c) the first opportunity to analyze data received from amateurs around the world on long distance HF propagation from a satellite.

Reports received from hundreds of observers in at least 27 countries are indicative of the international co-operation achieved in the *AO-5* programme. The co-operation between Australian builders and American amateurs has resulted in



Intelsat IV *satellite*

The 64 m diameter antenna of the Goldstone, California, earth station (ITU)

an exchange of information concerning *AO-5* and future amateur space programmes. The precedents established in international co-operation among amateurs and the training and educational benefits derived from the design, construction, testing and flight of *AO-5* are expected to be of great usefulness in future radio amateur satellite projects.

1.5 Mobile services

1.5.1 Aeronautical

Experimentation has continued in an effort to define the optimum system parameters and space radiocommunications techniques that will satisfy aeronautical communications and navigational requirements. Although not complete, the experiments include studies on absorption, scintillation, propagation and airborne antenna design.

1.5.2 Maritime

An extensive effort has been expended to identify maritime space radiocommunications requirements so that the needed technical capability could be more readily defined and developed. To support this effort tests have been carried out in the VHF and UHF bands using the *ATS-I*, *ATS-III*, and *ATS-V* satellites.

The United States cutter *Rush* participated in VHF position-fixing and voice communications experiments in the mid-Pacific. A long-time position accuracy of 1 nautical mile was achieved. Using the *ATS-V*, UHF signals relayed by-synchronous satellite were successfully used for navigation and data communica tion for the first time. Use of digital tracking techniques provided stable holding of the range measurements and partially overcame the signalling constraints imposed by the unintentional spinning of the satellite.

Detailed analyses of these and other tests are being made in an effort to define a practical operational satellite system for maritime use.

1.6 Radionavigation-satellite system

The Doppler/range radionavigation satellite system in the frequency bands 149.9-150.05 MHz and 399.9-400.05 MHz, which has been operational since 1968, continues to provide navigational information in support of ship operations. Advanced development of an airborne receiver is proceeding satisfactorily, and flight tests of the receiver have demonstrated the feasibility of using the system as a precision aid for continuous aircraft navigation. Commercial equipment is now available and use of the system is expanding for merchant shipping and off-shore drilling interests.

2. Research and development programmes

2.1 Applications technology satellites

Applications technology satellites take a major place in the space research programmes of the United Nations. *ATS-I* and *III* are still successfully accomplishing experiments including black-and-white and colour, full-earth, cloud-cover pictures; VHF communications experiments with ships, aircraft and other mobile stations; transmission of television; and a number of environmental measurement experiments. These satellites employ the 136 MHz and 137 MHz space research bands, the 148 MHz telecommand, 135.6 MHz spacecraft-to-earth and 149.22 MHz earth-to-spacecraft channels for the aero and marine VHF experiments, and the 4 and 6 GHz communication satellite bands for communication experiments.

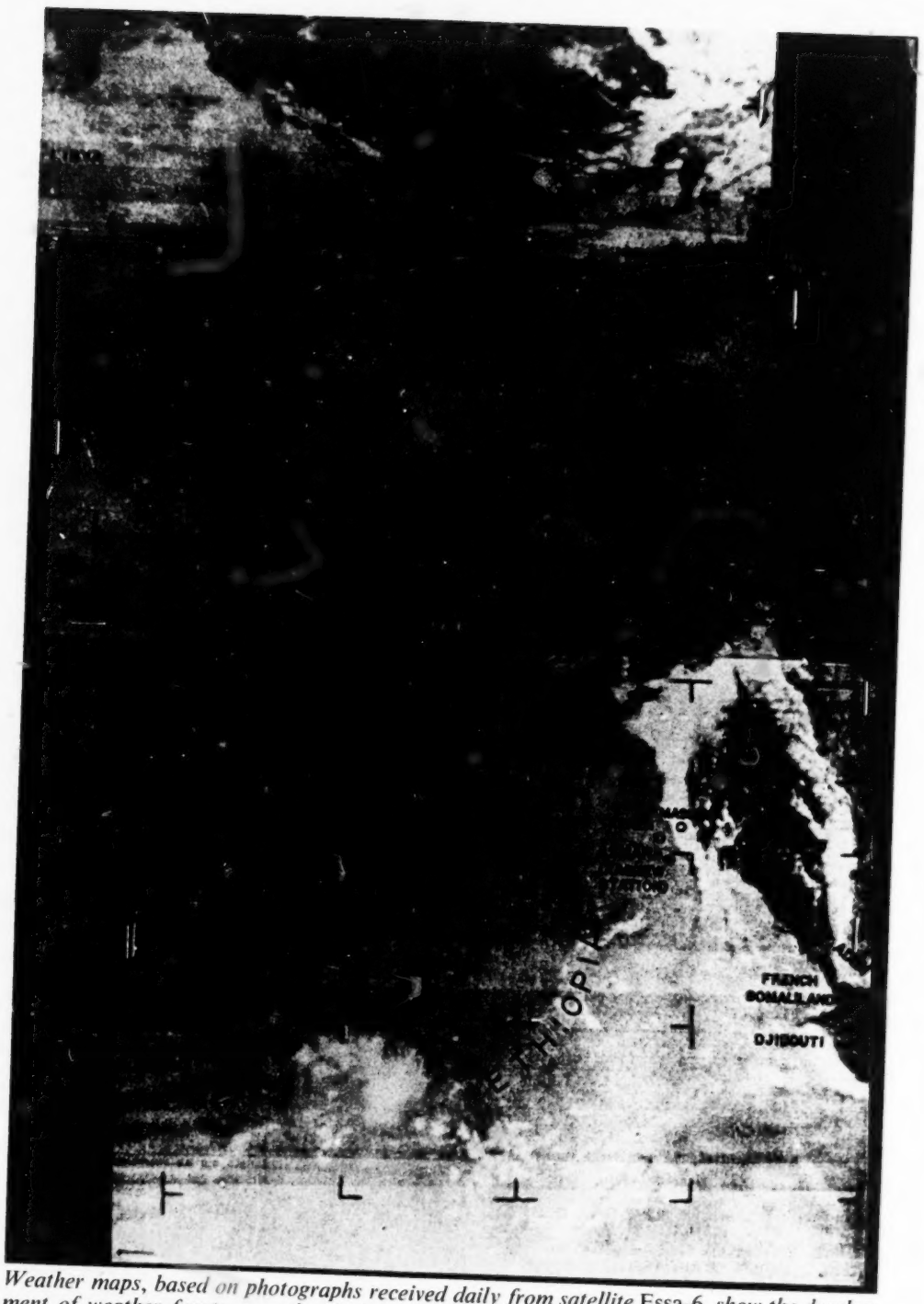
ATS-F and *G*, for 1973 and 1975 launches, are designed to develop technology for large (10 m) space erectable antennae with accurate (0.1°) pointing ability for various experiments, including providing good television signals to single, community operated, ground receivers. Additionally, air traffic control experiments utilizing the 1540-1660 MHz aeronautical radionavigation band will be accomplished and a series of co-ordinated tests designed to provide better frequency sharing data for space systems versus terrestrial systems will be made.

2.2 Deep space research

The Deep Space Network continued its support of the four on-going *Pioneer* missions *6*, *7*, *8*, and *9*. During this period, the Network also supported the highly successful *Mariner-6* and *7* missions following their fly-by encounter of the planet Mars. From 400 million kilometres in space, these two spacecraft gave scientists a rare chance to conduct an accurate experiment in an effort to determine the validity of the Einstein theory of relativity. Radio astronomers expect, by analysis of the *Mariner* signals in their pass close to the sun, to strengthen either Einstein's original gravitational theory or recent observations which suggest Einstein's predictions could be in error by as much as 10%.

The success of the deep space research is due largely to the 64 m antenna operating in a California desert area. The high gain of this antenna has permitted the reception of signals at unprecedented distances of 400 million kilometres from earth. The tremendous capabilities of this antenna lie in the gain which is more than eight times that of the standard 26 m deep space tracking antenna in use today. It is equipped to receive a wide range of frequencies into the 10 GHz range.

A Deep Space Network, including three of these out-size dish antennae, will be operational in 1973 in time for NASA's *Pioneer-F* space flight passing near Jupiter. The third and final link was started late 1970 in Madrid, Spain, when concrete was poured for the antenna base. The Madrid installation,



Weather maps, based on photographs received daily from satellite Essa-6, *show the development of weather fronts over the Red Sea. The movements of the fronts, particularly that connected with the inter-tropical convergence zone where the monsoon winds meet the north-east trades, are useful as the indicators of local movements of locust swarms which tend to concentrate along them*

(Photo Unit, FAO, Rome)

together with identical facilities at Canberra, Australia, and Goldstone, California, will give the United States the capability to communicate continuously from the earth with the most advanced spacecraft sent out to probe Jupiter, Saturn and the far planets of the solar system.

2.3 Manned space research

During 1970 NASA launched two manned flights, the *Apollo-XII* and *Apollo-XIII*. As in previous missions, all flight communications between capsule and earth were conducted in the UHF area on frequencies allocated for space research. Other than for telemetry use during the powered launch phase, VHF frequencies are now used only for communications between astronauts on the surface of the moon and between them and the orbiting command module. All contact between the spacecraft and the earth terminals is maintained in the 2100-2300 MHz area with excellent results as witnessed during the *Apollo-XIII's* historic return home after suffering a crippling blow midway in its flight to the moon.

3. Other areas of exploration

3.1 Time dissemination experiments

Experiments have been conducted to determine the usefulness of geostationary satellites for the dissemination of time in a one-way mode. Using the 300 MHz and 250 MHz transponders on the experimental satellites *Tacsat* and *LES-6*, the propagation delays from a master clock at a ground transmitter to five sites in North and South America have been measured. The measured values were compared against computed values obtained from orbital elements issued monthly. The results of these comparisons have indicated that within a two-week period about the epoch for the orbital elements, remote clocks can be synchronized to 150 microseconds. The results can be improved to 75 microseconds for the *Tacsat* and 25 microseconds for *LES-6*, when one observer of the timing signal is already synchronized to the master clock. These results were obtained using inexpensive narrow band receiving equipment. The operation of this equipment and the time recovery techniques were proved by field operation to be very simple. It appeared that the results obtained in these experiments are not limiting and that the potential for one-way synchronizations using orbital elements for delay calculations can be vastly improved.

3.2 Mobile experiments

3.2.1 SHF(3 to 30 GHz) satellite communications between aircraft

A major achievement in the art of mobile communications was recorded during October 1970 with the microwave radio link-up of two aircraft in flight, one over the eastern shores of the United States and the other over Australia. The

two-way voice contact between a helicopter and an aircraft at super high frequency (SHF) was effected through a geostationary communications satellite. The feat was made possible by a high-gain 81 cm parabolic antenna under a protective cover mounted atop the helicopter rotor to gain a path to the satellite unobstructed by the rotating blades. The antenna is kept pointed toward the satellite by a servo-mechanism driven from the pitch, roll and heading gyroscopes used for the other aircraft instruments. Drift in the gyrosystem is compensated by a supplemental target seeking system using a slow mechanical oscillation (conical scan) around the bore site axis. The antenna thus remains pointed towards the satellite despite aircraft motions. The airborne satellite communications terminal was adapted from a ground-vehicle configuration. The terminal has a transmitting power of about 100 W.

3.2.2 Small mobile terminals

The experimental programmes designed to explore the feasibility of using spaceborne repeaters operating in the UHF and SHF bands to provide communication service to small mobile terminals, made significant progress during the year. Using the satellites reported in previous years, experimental results were obtained with terminals installed on land vehicles, ships and aircraft. The test results have been very satisfactory and the data is now being analyzed. During this period the satellites *LES-6* and *Tacsat-I* have operated satisfactorily with no significant problems. *LES-6* has also demonstrated an automatic station-keeping system coupled with an electric propulsion system.

3.3 Solar radiation satellites

Solrad-9, the ninth in a series of solar radiation detection satellites, senses and records solar X-ray emissions and, upon command, telemeters the data to an earth terminal. Short-term solar flare activity forecasts, derived from information transmitted by *Solrad-9*, have safeguarded spacemen and their communications systems during space missions. Solar radiation fluctuates and can be in the form of intense electromagnetic waves and nuclear particle streams that are harmful to spacemen out of their vehicles. Because of this and the fact that solar radiation disrupts communications to and from the earth, these forecasts have become an important aspect of man's travel in space.

3.4 Microwave acoustic device

Design criteria have been explored for systems applications. One element utilizing lithium niobate possesses extremely low losses in the UHF region for receiving, coding, storing, and retransmitting signals. These components have excellent performance and resistance to almost all identified types of galactically generated radiations and offer extremely reliable transmissions when operating in a high noise modulated carrier system. This development appears to be of potential benefit to space communications.

3.5 VHF/UHF scintillation

Studies have provided data of value to the designers of communications and navigation systems for air commerce routes. These data, gathered from radiostar sources and synchronous satellites radiating to receiving stations arrayed worldwide at high, middle, and equatorial latitudes, are of particular value for determining fade margins in communications systems.

3.6 Synchronous satellite tracking for aircraft navigation

In respect to UHF signals from satellites, measurements have been made of propagation delays and fading brought about by changes in the total electron content (TEC) of the ionosphere. This information, which is a function of latitude, time of day and season, permits a mapping of predicted time/phase delays and establishment of first order correction factors. Application of these factors significantly improves the determination of an aircraft's geographic position.

FRANCE

1. Satellite communications

During 1970 the French Administration's activities were developed in various directions.

1.1 INTELSAT

As in other years since 1964, the French Administration as a member of the INTELSAT Consortium, continued to take an active part in the work of the Interim Communications Satellite Committee (ICSC) and its Sub-Committees.

The Pleumeur-Bodou satellite communication centre, which has two antennae, continued to operate transatlantic circuits via the *Intelsat-III* satellites. Since June 1970, the two antennae have been in continuous operation with each of the two *Intelsat-III* Atlantic satellites. By late 1970, Pleumeur-Bodou provided links with Argentina, Brazil, Canada, Iran, Mexico and Peru for France and some other European or Middle Eastern countries.

The French Administration also prepared the adaptation of the Pleumeur-Bodou II station for operation with the *Intelsat-IV* satellite on its launching in 1971, as well as for installing Spade demand assignment system equipment at this station in early 1972. All the traffic handled by Pleumeur-Bodou in the Atlantic zone will then be routed through the Pleumeur-Bodou II station so that the Pleumeur-Bodou I station may operate with the *Intelsat-III* satellite over the Indian Ocean.

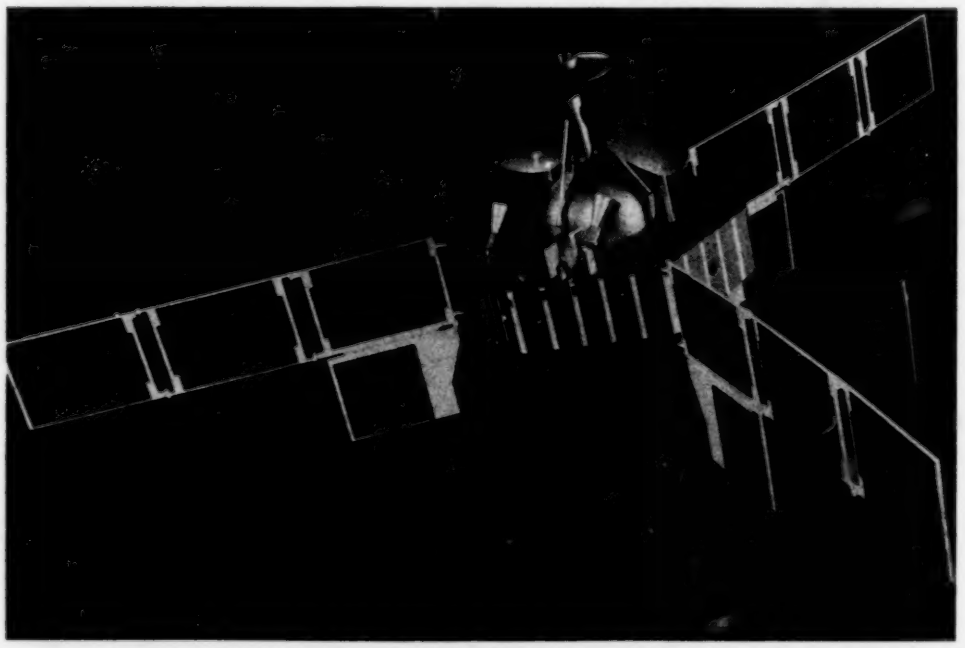
In addition, work is actively going ahead on the construction of a standard INTELSAT station in the French Overseas Department of the Antilles (Martinique), which is scheduled to come into service in mid-1971.

1.2 "Molnya"

On several occasions in 1970, colour television broadcasts (*Secam* system) were relayed by the *Molnya-1* satellite between France and the USSR in both directions making use of the Pleumeur-Bodou I station.

1.3 European programme

The French Administration continued to take an active part in the study of European communication satellites. For this purpose it delegated a French representative to the "permanent nucleus" set up by the European Conference of Postal and Telecommunications Administrations (CEPT) to ensure close co-operation in studying the definition of a satellite designed for telecommunication between European countries. This study has been entrusted to the European Space Research Organisation (ESRO) by the European Space Conference.



Model of the satellite Symphonie (CNES)

1.4 "Symphonie" programme

The construction of a prototype and two flight models within the *Symphonie* programme began in 1970 on termination of the design and feasibility phase. Tenders were also invited for the construction of two experimental earth stations for this programme. These stations, which will have an antenna 15 m in diameter, are specified with a figure of merit (G/T) of 31.5 dB.

2. Radionavigation by satellite

■ *"Dioscures" programme*

This is a project for an air navigation aid which was studied by the *Centre national d'études spatiales* (CNES) and the Office of the Secretary-General for Civil Aviation. Two series of experiments, in which the satellite-aircraft transmission system was simulated and studied under operational conditions, were carried out in 1970 with the aid of aircraft, stratospheric balloons and a ground station. The results will be communicated to the CCIR. The experiments were followed by ESRO which is co-operating with NASA in the study of the corresponding satellites. They are scheduled for launching in 1974.

3. Satellite meteorology

■ *"Eole" satellite*

Eole is designed for studying winds in the troposphere and is both a scientific research and an application satellite. Integration of the identification mock-up was completed by mid-1970, and the compatibility tests of the satellites and balloon nacelles were positive. The balloons had an average life of 120 days at 12 000 m. Equipment for their mass production was installed and began operation in late 1970. The three balloon launching stations in Argentina have been completed.

This satellite will be launched in autumn 1971 by an American *Scout* launch vehicle.

4. Satellite geodesy

■ *"Peole" satellite*

Successfully launched on 12 December 1970 from the Guyana launching pad by *Diamant-B* into a low equatorial orbit, this satellite has a dual task: to study the *Eole* satellite-balloon radio link, and to make geodesic measurements by laser echo as part of the international operation *Isagex* (International Satellite Geodetic Experiment).

5. Scientific space research

5.1 "D2-A" satellite

The difficulties found in qualifying the pneumatic system and the scientific experiments were overcome and integration of the qualifying mock-up was completed in June. All satellite equipment had been qualified by September. Flight model tests have been completed. Launching will take place on 15 April from the Guyana launching pad using a *Diamant-B*.

5.2 "D2-A" polar satellite

This is the second *D2-A* flight model. Two experiments have been modified. This satellite will be placed on a polar orbit and have tasks complementary to those of *D2-A*.

5.3 "D2-B" satellite

The vehicle itself is as similar as possible to the *D2-A*. The technical specifications for the satellite were completed in July in the light of the constraints imposed by experiments concerning solar activity at the zenith, atmospheric absorption at sunrise and sunset, stellar emission in the antisolar direction, stellar photometry and background sky brightness. Launching is scheduled for late 1973 by *Diamant-B*.

6. Technical space research

6.1 "SRET" programme

This programme concerns satellites for technical study and research to be placed in orbit by Soviet launch vehicles in addition to their main payload. The purpose of the *SRET (Satellites de recherches et d'études technologiques)* satellites, which are produced in France, is to try out new technical developments in actual conditions of use.

The first *SRET*, to be used to study the behaviour of thin layer solar cells, is ready. It will be launched by the USSR in 1971 and scientific interpretation of the results will be carried out in France.

6.2 Research and development

This has mainly been aimed at acquiring the techniques that will be needed by communications satellites in 1976-1980:

— solar generators with an electric power of more than 1 kW;

— 2, 12, 18 and 30 GHz electronic components;

— ionic propulsion for stabilization and correction of orbits.

7. Tracking, telemetry, telecommand

In 1970 the network of CNES stations continued its activities in connection with the following:

— *Peole*, the latest French satellite to be launched; *D1-A*, still in operation; *D1-C* and *D1-D*, continuing to be used for laser measurements;

— the German satellite *Dial*, launched by *Diamant-B* from the Guyana launching pad in March 1970;

— the Canadian ionospheric satellites *Alouette* and *Isis*;

— the American satellites *Essa/NOAA*, *Nimbus*, *Itos*, *Solrad*;

— the ESRO satellites, *Esro-1* and *2*, *Heos-A1*.

GREECE

The Greek earth station located at Thermopylae commenced operation with the Atlantic region *Intelsat-III F6* satellite on 21 April 1970.

The station which is operated by the Hellenic Telecommunications Organization (OTE) is located near the historic site of Thermopylae, 185 km from Athens.

A radio-relay system of three radio-frequency channels (one for telephony with a capacity up to 1800 telephone channels, one for television and a common stand-by) links the station with the international exchange in Athens.

The earth station comprises a main control building, power and utility buildings and the antenna system which consists of a 30.5-metre diameter, fully steerable paraboloid antenna using an elevation over-azimuth mount.

The antenna gain is 63.5 dB at 6090 MHz and 61.2 dB at 4165 MHz. At the frequency of 4165 MHz the figure of merit G/T has been measured 43.1 dB at 5° and 44.3 dB at 20° elevation.

Today Thermopylae is operating with the *Intelsat-III F7* satellite, providing commercial telecommunications with Canada, the United Kingdom and the United States. The station is also equipped to receive and transmit colour and black-and-white television.

It is scheduled that the station will transfer the service from *Intelsat-III* to *Intelsat-IV* during the second quarter of 1972 and at the same time it will be ready to use the Spade demand assignment system, in order to establish direct communications with other stations in Africa and South America, which will be suitably equipped.

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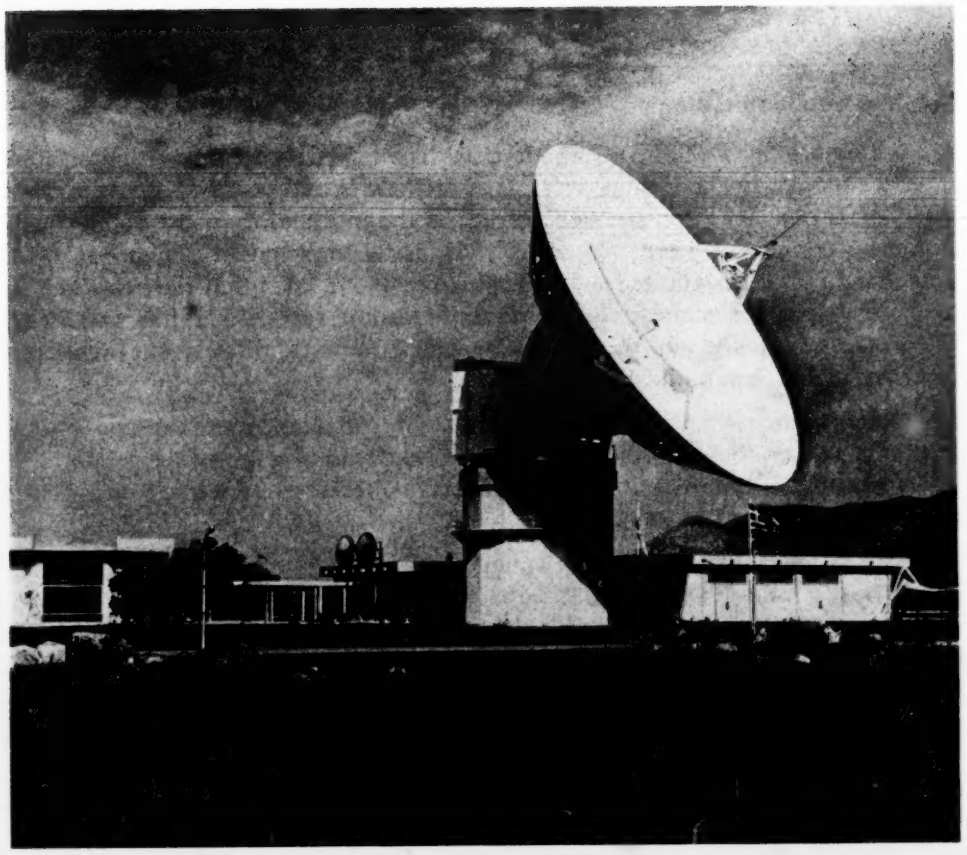


The earth station in Greece

The possibilities of establishing a second antenna for the Indian Ocean *Intelsat* satellites are now being investigated. Provisions have already been made at the site in order to accommodate the necessary additional antennae. Considerable attention is also being given to the discussions concerning a possible European satellite system.

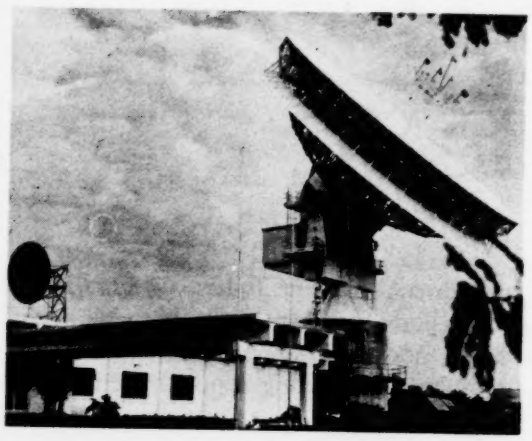
INDONESIA (REPUBLIC OF)

Satellite communications

As a member of INTELSAT, Indonesia has built a communication ground station situated at Djatiluhur, West Java (107°20′E and 06°20′S), some 100 km from Djakarta. The construction work and the installation of the antenna and electronic equipment were started in 1968 and completed in September 1969. This station was inaugurated on 29 September 1969; since that time this facility has been used for commercial telecommunication service via the *Intelsat-III* Indian Ocean satellite and recently for several experimental television broadcasts from Australia, Japan and Spain.

The station, which is managed by the Ministry of Communication, was constructed as a joint venture between the Government Telecommunication Corporation and the Indosat Corporation; the Indonesian National Aeronautics and Space Institute participated in its erection.

The station has a 30 m Cassegrain antenna and provides a direct communication link with Australia, the Federal Republic of Germany, Hong Kong, Italy, Japan, Malaysia, Spain, the United Kingdom and West Pakistan. It is now using 6320 MHz for transmission and 4095 MHz for reception. The earth station is connected to the Djakarta microwave terminal through a microwave link allowing for transmission of up to 6000 telephone channels and two-way television.



The 27 m diameter antenna of the Djatiluhur (Indonesia) earth station
(ITT)

During this year, several television broadcasts have been received from Malaysia, Mexico, Thailand and the United States.

A feasibility study has been conducted to prepare a second ground station antenna in an effort to use the *Intelsat* Pacific communication satellite.

Meteorological satellites

A careful plan preceded by a feasibility study started in 1967 was prepared for an automatic picture transmission (APT) station system. The first APT ground station will be installed by the end of 1970, to provide cover of the whole western region of Indonesia. The second APT ground station will be built at Biak, West Irian, early in 1971 and will cover the whole eastern region of Indonesia.

The erection of these APT ground systems has been conducted by the Indonesian National Aeronautics and Space Institute, supported by and in co-operation with the Institute of Meteorology and Geophysics and the Indonesian Air Force Bureau of Meteorology. By using the APT data it is hoped that Indonesia could improve the meteorological services to the benefit of aviation, agriculture, sea communication and other development projects.

Reference

"National Report on Space Research and Space Activities in Indonesia", presented at the Thirteenth Plenary Meeting of the International Council of Scientific Unions (ICSU) Committee on Space Research.

IRAN

The Iranian earth station for satellite communication at Assadabad went into operation on 5 October 1969 and has been working perfectly since.

The station operates with satellite *Intelsat-III F7* and it provides communication circuits from Iran to most of the European as well as North American countries.

Transit circuits have also been established through the earth stations in those countries. The Assadabad earth station is handling all two-way international communications (such as telephone, telegraph, telex, facsimile and television) of Iran with the western world. Steps have been taken to up-grade the station and make it ready for use with the new *Intelsat-IV F1* satellite.

Before September 1971 the available capacity of the station will be the equivalent of 60 telephone channels plus two-way television instead of the actually existing 24 channels plus television. In addition the Ministry of PTT of Iran intends to

join a group of countries using the Spade demand assignment equipment system over satellite circuits from 1972. In this way direct communications will be available with earth stations other than those already in direct contact with Assadabad.

Finally we intend also to up-grade our earth station by adding a second antenna by 1973 for use with the Indian Ocean satellite to establish direct circuits with most Asian countries and Australia.

ISRAEL (STATE OF)

In 1969 a tender was issued by the Administration of Israel for procurement of the equipment and for the construction of a satellite earth station in the country. Proposals were received in May 1970, the evaluation of which was completed by October 1970.

The tender was awarded in November 1970 to GT&E International Systems Inc., Waltham, Massachusetts, as prime contractor. In accordance with the agreement signed between the Ministry of Posts and the above contractor the latter will build the complete earth station (except the terrestrial microwave link system) within 18 months from the date of signing the agreement.

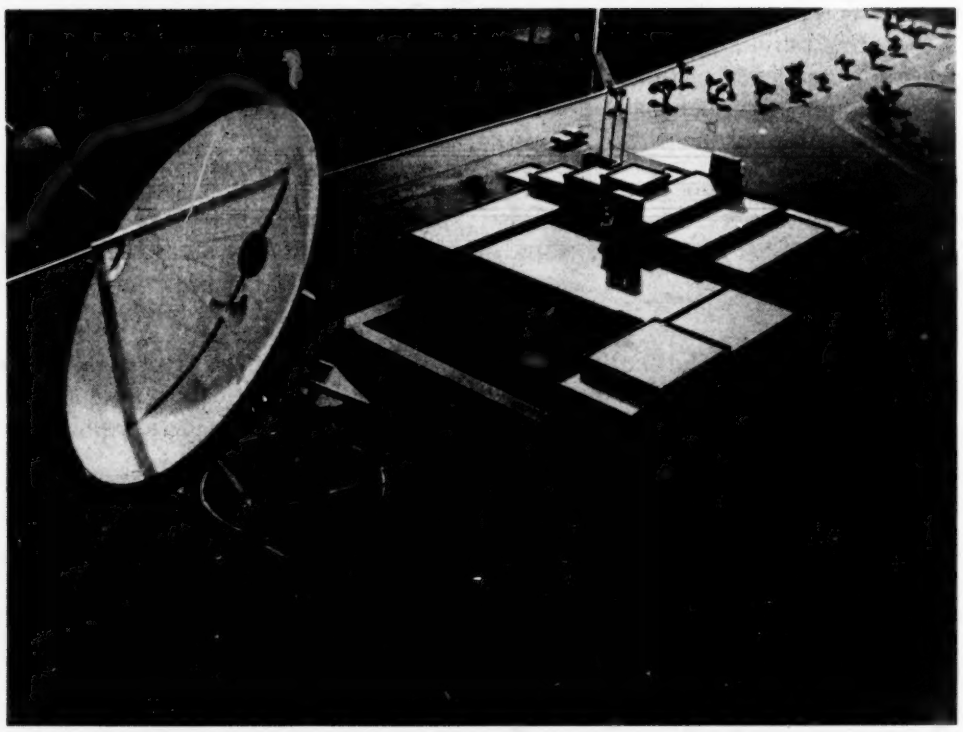
A large part of the earth station will be installed by GT&E International Systems Limited, Israel, a subsidiary company of the prime contractor, employing Israeli engineers and technicians.

The selected site lies in the historical valley of Emeq Ha'ela where, according to the Bible, David slew Goliath. This valley, situated about 45 km south-west of Jerusalem, is surrounded by hills providing a degree of protection against mutual interference with other services.

The site occupies land of about 13 hectares and its layout is such that there is ample space left for a second antenna. The buildings have already been planned to house in the future the equipment of a second antenna.

The first antenna will be of the Cassegrain type with a reflector diameter of 30 m. It will be fully steerable having an azimuth/elevation "wheel and track" construction. The system G/T will be better than 40.7 dB at 5° elevation angle.

Split level elevated equipment rooms situated behind the reflector will house the low noise amplifiers and the high power amplifiers. The control console, the communication equipment and the multiplexing equipment will be installed in the control building situated about 50 m from the antenna and connected to it by flexible waveguides.



Model of Emeq Ha'ela earth station, Israel (Ministry of Posts, Israel)

Five high power amplifiers, having 3 kW klystron tubes, will be installed. A sixth amplifier could be added in the future should Spade demand assignment equipment operation be required. The message carrier transmitters, the low-noise amplifier and the receiver chains are duplicated to enable automatic changeover in case of failure of any one of them.

Initially two Diesel generators will automatically provide power should a failure in the mains supply occur. Redundant static inverters will supply uninterrupted power to bridge the time gap between a mains failure and the start-up of the generators.

Every step has been taken to prevent, as far as possible, any interruption of the service, the continuity of which is essential considering the large number of message, telegraph and telex channels passing through the station and considering that international subscriber dialling will be gradually introduced in Israel soon after the inauguration of the earth station.

The first antenna will operate with the Atlantic region *Intelsat-IV* satellite. It will transmit two carriers: one via the "east" spot beam transponder and one via the "west" spot beam transponder of the above satellite. The power of each of the higher power amplifiers is sufficient to transmit one spot beam carrier with 432-channel capacity.

One transmitter is dedicated for television video and sound transmissions. This transmitter will be used also for the Israel-France submarine cable restoration as well as a possible standby for the sixth transmitter used for Spade transmissions.

Initially, ten receiving chains will be installed. It will be possible, if necessary, to add more receivers at a later date. The control console, the alarm, monitoring and testing facilities have been engineered to enable the operation of the station with a minimum of personnel (the training of which is already well under way).

It is expected that the Emeq Ha'ela earth station will be inaugurated in the summer of 1972 and will provide in addition to the urgently required voice channels, television facilities for the coming events of the 1972 Olympic Games.

ITALY

The most important accomplishment during 1970 was the implementation by *Telespazio* of the Fucino II antenna, which became operational on 21 July. The 29.56 m diameter antenna makes possible the establishment of several direct circuits with countries in Asia and Oceania through the *Intelsat-III F3* satellite stationed over the Indian Ocean. The Piero Fanti earth station at Fucino is thus linked to the countries included in the areas covered by the satellites in orbit over the Atlantic and Indian Oceans.

Television broadcasts through the Fucino earth station amounted to 3502 minutes in the period from 1 January through 30 November 1970.

As regards the research and development field, a project for educational television in the Latin American countries sponsored by the *Consiglio Nazionale delle Ricerche* (CNR)—National Research Council—was carried out by Telespazio.

The following circuits were in operation on 30 November 1970.

terminated circuits	Atlantic area	Indian area
Italy — United States	73	
Italy — Canada	9	
Fucino — COMSAT (Washington, DC)	1	
Italy — Chile	3	
Italy — Panama	1	
Italy — Mexico	6	
Italy — Brazil	7	
Italy — Peru	3	
Italy — Argentina	7	
Italy — Japan		1
Italy — Japan (Bern Pool		2
Italy — Australia		2
Italy — Kuwait		2
Italy — Kenya		2
total	110	9

transit circuits	Atlantic area	Indian area
Switzerland — United States	12	
Libya — United States	1	
Turkey — United States	1	
Israel — United States	6	
Portugal — Brazil	1	
United Kingdom — Panama	1	
Czechoslovakia — United States	1	
France — Japan (Bern Pool)		1
Switzerland — Japan		1
total	23	2

Telecommunications experiments were also carried out during 1970 in connection with the *Sirio* project, which envisages the launching in 1972 of a satellite devoted to SHF transmissions.

JAMAICA

An earth station is at present under construction in Jamaica by Cable and Wireless Limited for Jamaica International Telecommunications Limited (JAMINTEL), the joint Company which is being formed between the Government of Jamaica and Cable and Wireless Limited and which will start commercial operations on 1 April 1971. This Company will operate the island's external telecommunications and it is expected that the earth station will be ready for service in the last quarter of 1971. This station will be equipped to operate with any of the *Intelsat* series of satellites including *Intelsat-IV*. At present it is planned to work to *Intelsat-III* (17° W). Direct circuits are foreseen with Barbados, Canada, Trinidad, the United Kingdom and the United States.

JAPAN

Success of "Ohsumi", Japanese satellite No. 1

The artificial satellite *Ohsumi*, which Japan successfully launched and placed into orbit on 11 February 1970, transmitted beacon signals continuously for a period covering about three complete orbits. These signals, which were received at several earth stations and tracking stations, established clearly that a Japanese satellite had been put into orbit.

Thus Japan has become the fourth country capable of launching satellites by its own efforts following the USSR, the United States and France.

The Committee on Space Research (COSPAR) has given the international designation "1970-11A" to this satellite. By virtue of this success Japan, while confirming its development capacity in the field of space communications, has increased the scope for its participation in the field of world-wide space communications.

Satellite communication service

The exchange of information via satellite on a world-wide scale is becoming steadily more commonplace. This applies especially to the exchange of television programmes which are now actively relayed between our country and many other countries of the world. For instance, early in the spring, such programmes as films on the opening ceremony and the national days of EXPO '70 (the international exposition held in Japan in 1970) were broadcast to countries throughout the world and, in mid-autumn, television programmes were exchanged by satellite between Japan and

Italy through the co-operation of the *Nippon Hoso Kyokai* (NHK), the Japan Broadcasting Corporation and the *Radiotelevisione Italiana* (RAI), the Italian Broadcasting Corporation. For this transmission the Kabuki (a traditional play in Japan) was televised from Japan to Italy, and, in the reverse direction, an opera from Italy to Japan. In both cases this was done via the geostationary satellite located over the Indian Ocean. The transmission services were provided in this country by the Kokusai Denshin Denwa Company Limited (KDD), the Japanese designated communications entity in INTELSAT.

As a result of the completion in 1970 of the global network (over the Pacific Ocean, the Atlantic Ocean and the Indian Ocean) of the geostationary satellites belonging to the *Intelsat-III* series, communication coverage between Japan and many other countries has been further expanded.

Research and development

Satellite communications have become firmly established as a means of coping with the world-wide trend of transmitting information in increasing volume. This requires research and development work in order to increase considerably the communication capacity of satellites.

Two examples of this work are the techniques using

i) millimetric and shorter centimetric bands, and

ii) time division multiplex communication systems.

This research is being conducted at the Radio Research Laboratories of the Ministry of Posts and Telecommunications, the Electrical Communication Laboratory of the Nippon Telegraph and Telephone Public Corporation (NTT) and the Research Laboratory of the KDD.

These laboratories are working extensively on the technical problems associated with the use of the millimetric and shorter centimetric bands as well as on the time division multiplex communications. These techniques conveniently allow for an increase in the traffic capacity of the satellite communication systems because they can be used in conjunction with pulse code modulation which is advantageous in the presence of noise.

Preparation for launching scientific satellites

A series of scientific satellites have been prepared for launching in the wake of *Ohsumi*, Japanese satellite No. 1. These artificial satellites will carry out observations on the physical environment surrounding the earth.

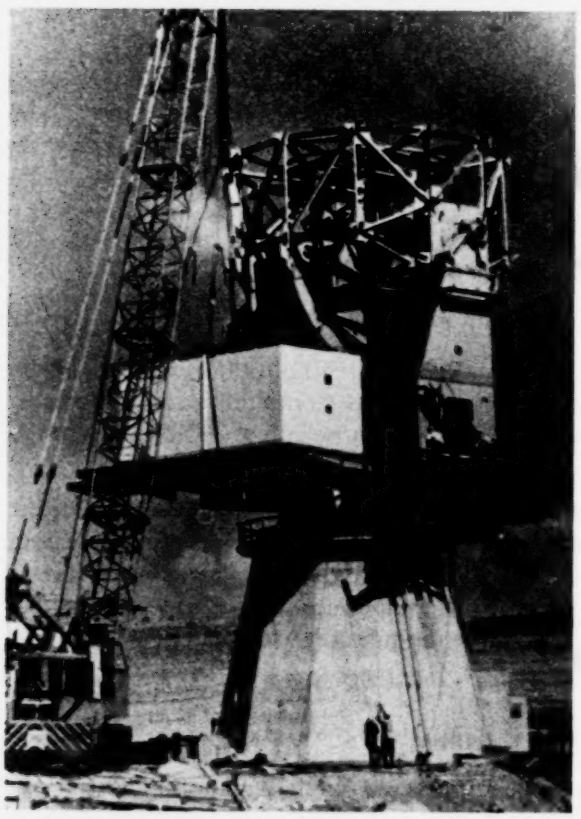
In advance of launching these scientific satellites, Japan will launch an experimental satellite in the course of February 1971. This satellite will carry a chemical battery. The life of the battery will be only about a week, but as the satellite will be equipped

with mirrors installed on its sides, optical observation will be possible even after the battery has ceased to function.

It is later expected to launch the above-mentioned scientific satellites Nos. *1-6* with the help of *M*-type rockets.

JORDAN (HASHEMITE KINGDOM OF)

The Jordan earth station is under installation at present.



Earth station under construction in Jordan
(Ministry of Communications, Jordan)

The Jordan earth station will operate with France, Italy, Morocco, Spain, the United Kingdom and the United States to provide telephone, telegraph, telex and television services for Jordan and neighbouring countries.

KENYA, UGANDA, TANZANIA (UNITED REPUBLIC OF)

Details of East Africa's communication satellite tracking station

The contract for the supply and installation of the antenna and most of the equipment was awarded to the Marconi Company Limited of England on 29 November 1968.

The site for the earth station is situated some 30 km north-west of Nairobi in the Rift Valley. The position of the antenna is: 01° 00′ 58″ S; 36° 29′ 43″ E.

The end link between the earth station and the international switching centre in Nairobi is being supplied by the East African Posts and Telecommunications Corporation (EAPT). This will consist of a *Fujitsu* microwave link capable of carrying 600 telephony channels in the 2 GHz band. Multiplex equipment will be supplied by *Telettra* (Italy).

The earth station to be supplied by Marconi will be a standard earth station for the *Intelsat-III* series of satellites and some technical details are listed below:

Antenna

— Cassegrain, 30 m shaped main reflector with 2.7 m diameter sub-reflector

— fully steerable, elevation over azimuth mount on a reinforced concrete tower

— degree of rotation: +270° in azimuth, —2° to 92° in elevation.

The tower will be on piled foundations and will be situated 150 m due north of the control buildings.

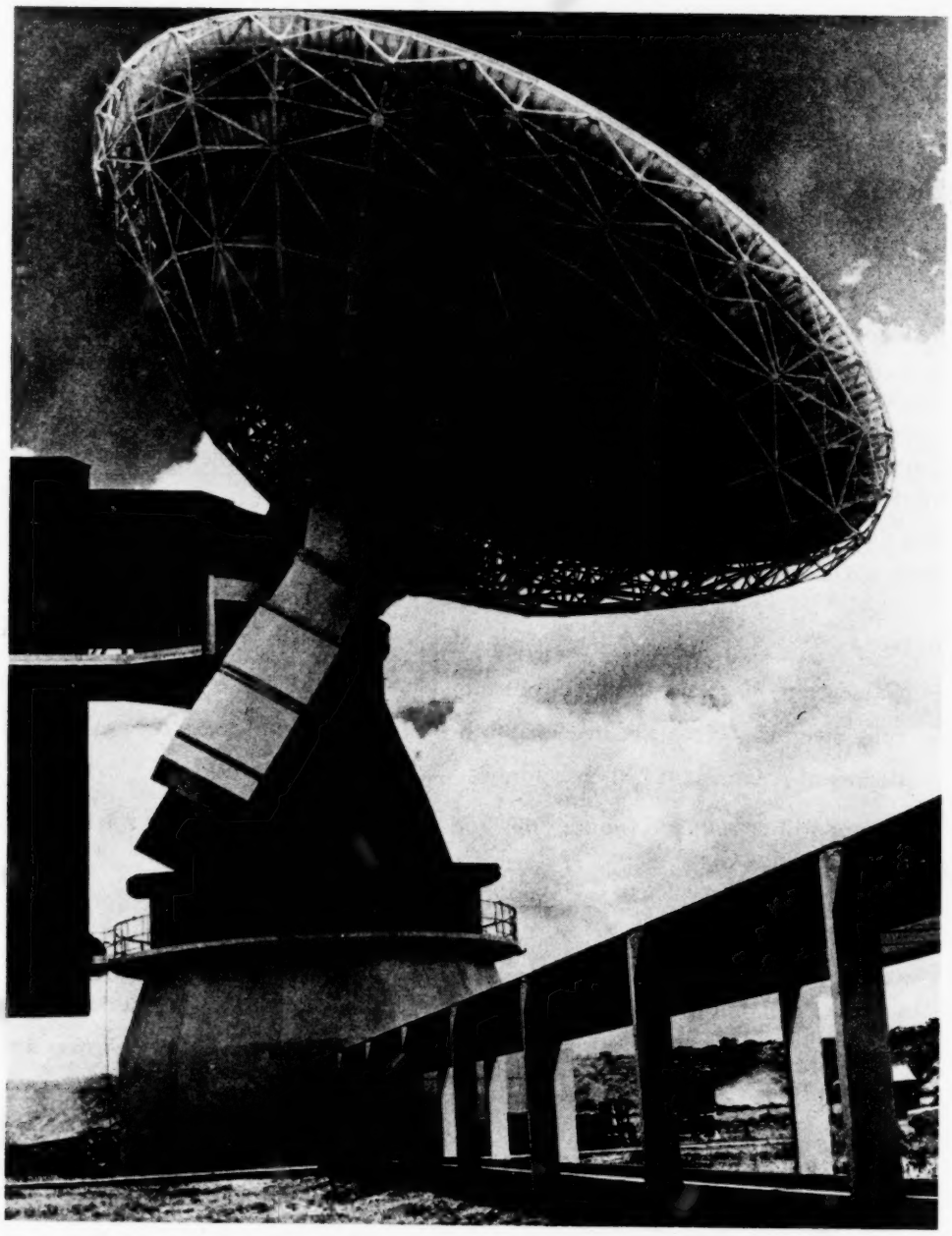
Intersite connections

The equipment of the antenna tower will be connected to that of the control buildings by waveguide on the receive side and by coaxial cable on the transmit side.

All connections will be taken through an enclosed covered way between tower and control room.

Receive

Cryogenically cooled parametric amplifiers will be manufactured either by Comtech or Marconi—the final decision to be made at a later stage. Both will use *A.D. Little* refrigeration. They will be situated in a large cabin over the king post and will be fixed in elevation. The parametrics are followed by low noise TWTS, inter-site waveguide, power dividers down converters and Marconi threshold extension demodulators using FM feedback.



Antenna of the Mount Margaret earth station, Kenya (Marconi)

Transmit

Marconi manufactured modulators will be used to feed the baseband into the 150 m coaxial inter-site link. The power amplifiers are still under consideration but will probably be in the order of 3 kW air cooled. The transmit side will be duplicated for redundancy purposes.

Feed

A monopulse feed system will be used (probably *RCA* type *4/6-500*) with provision for either linear or circular polarization.

Tracking receiver

Monopulse tracking receivers will probably be employed (*RCA* type *SCM-4* single channel).

Television

This is not being catered for initially but station design is such that television facilities can be added easily when required.

General

The station will be completed according to the latest Interim Communications Satellite Committee (ICSC) of INTELSAT requirements.

Ready for service date

1. The satellite communications station was commissioned on 10 August 1970, and we now have direct circuits to Australia, Italy and the United Kingdom.

2. United States Communications Satellite Corporation (COMSAT) line-up activities with the United Kingdom were completed on 20 August 1970 and 18 telephone circuits were established by 10 September 1970. Circuits are terminated in Kenya, Uganda and Tanzania.

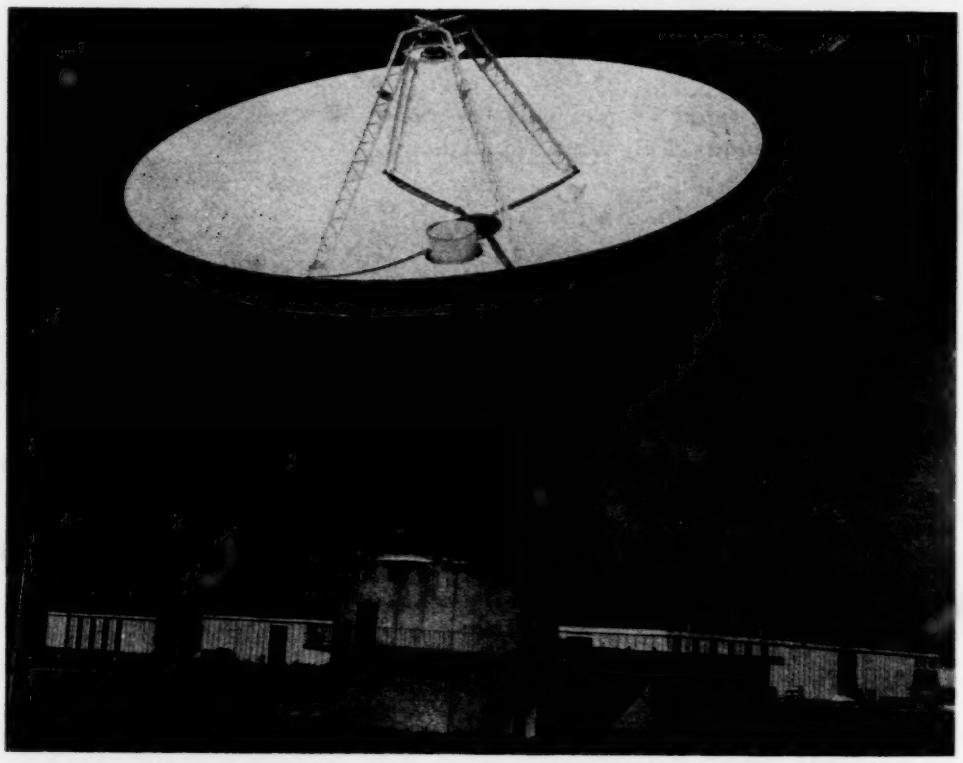
3. COMSAT line-up activities with Ceduna, Australia, were completed on 26 August 1970 and 2 telephone circuits were established by 3 September 1970.

4. COMSAT line-up activities with Fucino, Italy, were completed on 23 October 1970 and one telephone and one record service channel were established by 2 November 1970.

KUWAIT (STATE OF)

Present earth station

A satellite radiocommunications earth station was established in Kuwait in 1969, to work with Bahrein, Germany, India, Italy, Japan, Lebanon, Pakistan and the United Kingdom through the Indian Ocean satellite system of INTELSAT. This station started actual telephone and telegraph service with the United Kingdom, Bahrein, Japan and Germany from October 1969.



Antenna of the Umm Al-Aish earth station, Kuwait
(Ministry of Guidance and Information, Kuwait)

In 1970, additional direct telephone and telegraph services were established with Italy and Spain. Services with India, Lebanon and Pakistan are expected to be started in 1971, when the earth stations of these countries would be ready for service.

The number of voice circuits established until the end of 1970 through the Indian Ocean region INTELSAT system are shown below:

destination	number of voice circuits	
	telephone	telegraph/telex (VFT)
Bahrain (including Doha, Dubai, etc.)	6	1
United Kingdom	4	1
Japan	1	1
Germany	1	—
Italy	1	1
Spain	1	—
total	14	4

The overall efficiency of the earth station, established at Umm Al-Aish, Kuwait, was better than 99.5% throughout the year 1970.

Future plans

In view of the heavy growth of traffic noticed in the existing services, it was decided by the PTT Administration early in the year to build a second earth station, to work with a number of additional countries of the world, including Algeria, France, Jordan, Morocco, Saudi Arabia and the United States, via the INTELSAT Atlantic Ocean region satellite system. Preliminary studies having been completed, draft specifications are now under preparation. It is expected to establish the new earth station by the end of 1972, so that actual operations could start from early 1973.

MALAGASY REPUBLIC

The project to build an earth station in the Malagasy Republic has reached the stage of preliminary field studies. The station is scheduled to be brought into service in the first quarter of 1972.

NIGERIA (FEDERAL REPUBLIC OF)

1. Lanlate I satellite communication earth station

The Lanlate earth station came into operation on 29 March 1971 to provide commercial service with European and United States administrations via the *Intelsat-III* satellite positioned in the Atlantic Ocean area. The presently allocated carrier frequency baseband provides for 24 voice grade circuits.

During the latter part of the year, the station will transfer to the *Intelsat-IV* satellite positioned in the Atlantic Ocean area. The allocated carrier frequency baseband will provide for 60 voice grade circuits.

2. Initial utilization of the facilities

Thirteen voice grade circuits, 12 for record traffic and 1 for message traffic multiplexed for telegraph and telex, are planned for operation with European administrations. Three voice grade circuits, 2 for record traffic and 1 for message traffic multiplexed for telegraph and telex, are also planned for operation with the United States.

3. Principal characteristics of Lanlate I earth station

3.1 General characteristics

— satellite	at present operates with *Intelsat-III* and later with *Intelsat-IV* satellite
— transmit-frequency	5.925-6.425 GHz 2 message carriers capable of carrying 132 voice channels
— receive frequency	3.700-4.200 GHz carriers each capable of carrying 132 voice channels
— monochrome television	video and audio
— initial capability	24 voice channels
— initial traffic	United Kingdom 14 channels United States 3 channels Ethiopia 1 channel in 1972

3.2 Antenna characteristics

— type of antenna	Cassegrain
— RF system	
— elevation over azimuth axis	
— wheel and track pedestal	
— diameter	29.1 m
— focal length	10.8 m
— angular coverage	
— elevation	0°—90°
— azimuth	±180°
— antenna velocity	0.3°/s
— antenna acceleration	0.3°/s²
— receive gain	at 4 GHz: 60 dB
— transmit gain	at 6 GHz: 63 dB
— antenna G/T	at 4 GHz and 5° elevation: 40.7
— reflector surface accuracy	1.2 mm/rms at 48 km/h wind velocity
— wind velocity limit (stow position)	192 km/h

3.3 Transmit equipment

— three 300 W travelling wave tube power amplifiers	
— e.i.r.p.	82.2 dBW (132 channels—*Intelsat-III*)
— bandwidth	500 MHz
— frequency	5925-6425 MHz

3.4 Receive equipment

— parametric amplifiers	2 cryogenic cooled and 2 ambient temperature stages
— bandwidth	500 MHz
— frequency	3700—4200 MHz

— noise temperature	20° K
— gain	40 dB minimum

3.5 Power supply

— standby Diesel generators	2—500 KVA
— battery plant capacity	
— earth station	2 hours
— microwave repeater stations	12 hours

3.6 Terrestrial link characteristics

— frequency	6430—7110 MHz
— diversity	hybrid (frequency diversity on separate paths)
— terminal	Necom house extension—Lagos and Lanlate
— repeater stations	Alabata Road Junction Ogidan Ikorodu
— output power	+28.0 dBm
— reliability	99.999%
— capacity	300 voice channels (both directions of transmission) 1 television channel, monochrome or colour (Lanlate to Lagos direction of transmission only)

4. Other features of the system

4.1 Antenna

The antenna is of azimuth-elevation type on a wheel and track pedestal with elevated equipment rooms which house the servo systems, cryogenics and the high power amplifiers. The equipment room is fully air-conditioned.

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4.2 Control building

A very convenient control building is provided to house equipment for the Lanlate I control console, rearward microwave and multiplex systems, engineering service channel rack and 625-line television receiving rack. Office accommodation is also provided and space has been reserved for the installation of associated equipment for the Lanlate II antenna. The control building is fully air-conditioned.

4.3 Utility building

The utility building houses the 500 kVA standby Diesel generators which will provide standby power for the station and also emergency standby power for the staff quarters.

4.4 Staff quarters

Staff quarters which will house the operational and maintenance staff are under construction and will be completed by early 1972. Recreational and welfare buildings are annexed to the staff quarters.

5. Lanlate II earth station

Planning is under way for the erection of a second antenna with associated equipment by the end of 1972. The second station will provide commercial service via the *Intelsat-IV* satellite in the Indian Ocean area with East African and Asian administrations.

NEW ZEALAND

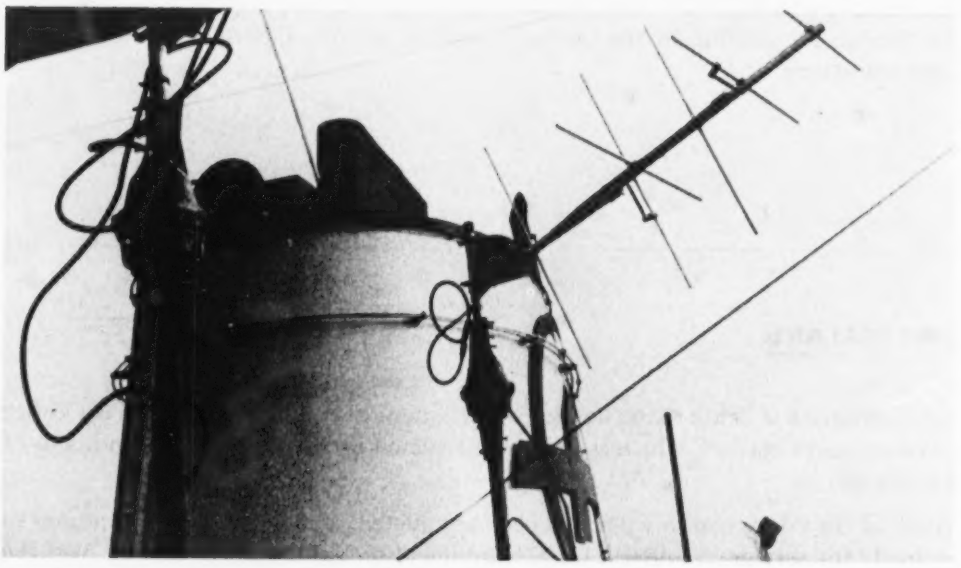
Good progress is being made in the establishment of the New Zealand Post Office standard earth station, which is being constructed at Warkworth, 55 km north of Auckland.

Much of the construction work has been completed, and the station is expected to be ready for service in mid-1971. Communication will be via a satellite over the Pacific Ocean.

NETHERLANDS (KINGDOM OF THE)

Satellite communication

In 1970, the Netherlands PTT, with the assistance of *Radio Holland* and *Holland-Amerika Lijn*, embarked on a programme of long-distance communication trials with shipping using the VHF *ATS-3* satellite. The purpose of the tests is to acquire more information on the practical utility of frequency modulation, single sideband modulation and narrow-band frequency shift modulation techniques for future VHF satellite communication systems. A number of theoretical and practical studies of frequency modulation have already been carried out. Single sideband modulation, however, might have the advantage of requiring a much narrower frequency band, not only because the bandwidth per channel is smaller but also because, in principle, this modulation system permits duplex operation with both participants able to use the same transmitting frequency.



Antenna on board the Atlantic Crown (Netherlands PTT Administration)

The programme is carried out in two stages. In the first stage, from 4 August to 8 November 1970, test transmissions with selective calling and facsimile signals were made by the NASA earth station at Mojave using frequency modulation. The transmissions were received by a ship of the Holland-Amerika Lijn, the *Nieuw Amsterdam*.

In the second stage, which is now proceeding, test transmissions in telephony, selective calling, facsimile and multichannel telex (narrow-band frequency shift modulation, the shift being 85 Hz) are made by an experimental earth station at Kootwijk and two ships, the *Nieuw Amsterdam* and the *Atlantic Crown*, using single sideband modulation.

It is considered particularly important that the mobile equipment in any future system should be inexpensive. For this reason simple apparatus is used for the tests; Yagi type antennae with only 6 dB gain and a transmitter with a maximum power of 200 W are used on board ship.

PERU

In December 1970, the earth station at Lurín transmitted and received a total of 43 voice grade channels (10 for telegraphy and telex and 33 for telephony) which, in comparison with the January 1970 capacity of 28 voice-grade circuits (10 for telegraph and telex and 18 for telephony), represents an increase of 60%.

International telephone traffic via satellite increased on average 7% per month during 1970 and, in December, 86 396 charged minutes of outgoing telephone calls were registered.

Between 21 August and 21 October the Lurín earth station, at the request of COMSAT, took part with 20 other earth stations in a multinational project known as "Satellite link signal variations". Throughout the duration of the project the levels of the carriers from the United States and the beacon signal of the satellite were monitored 24 hours per day and variations of up to ± 3 dB were detected. The recordings of the signals were sent directly to COMSAT for evaluation.

The station will soon join the Spade demand assignment equipment system. Agreements have been concluded for the acquisition of the new equipment required for use with the *Intelsat-IV* satellite; both this equipment and that for the Spade system will be manufactured by the Nippon Electric Company, Limited, Japan.

FEDERAL REPUBLIC OF GERMANY

1. Satellite telecommunication service

1.1 Since the installation of antenna system II in October 1969, two antenna systems have been in operation at the Raisting earth station. Whereas antenna system I works with *Intelsat-III F3* (Indian Ocean), system II is used for traffic routed via the *Intelsat-III F6* satellite in the Atlantic Ocean area.

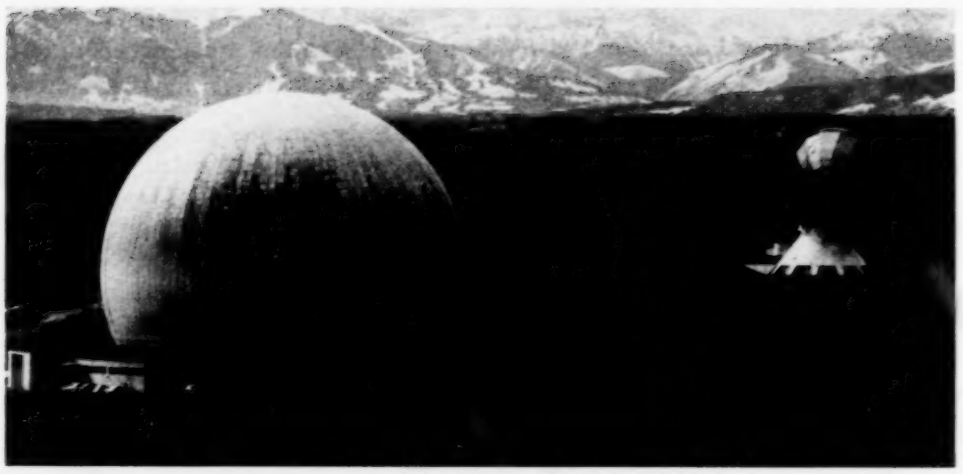
System I transmits the traffic for Indonesia, Japan, Kuwait and Thailand. It is planned to establish further links by means of these antennae with Australia, India and the Philippines.

Antenna system II provides connections with Argentina, Brazil, Chile, Colombia, Peru, the United States of America and Venezuela. Links with Mexico, Israel and the Congo are planned.

Both antennae are equipped for transmitting and receiving television picture and sound carriers. Preparations are being made to adapt the technical equipment of antenna system II to the *Intelsat-IV* system. In view of the growing number of countries belonging to the *Intelsat* network and the increased circuit requirements, it now seems probable that, by the beginning of 1973, one *Intelsat-IV* satellite will no longer be sufficient to meet the demand for circuits in the Atlantic area. It will therefore be necessary for the Federal Republic of Germany and some other countries to send part of their traffic by a second satellite. Work has accordingly begun in the Federal Republic on a third antenna system. The main elements of the foundations are already completed.

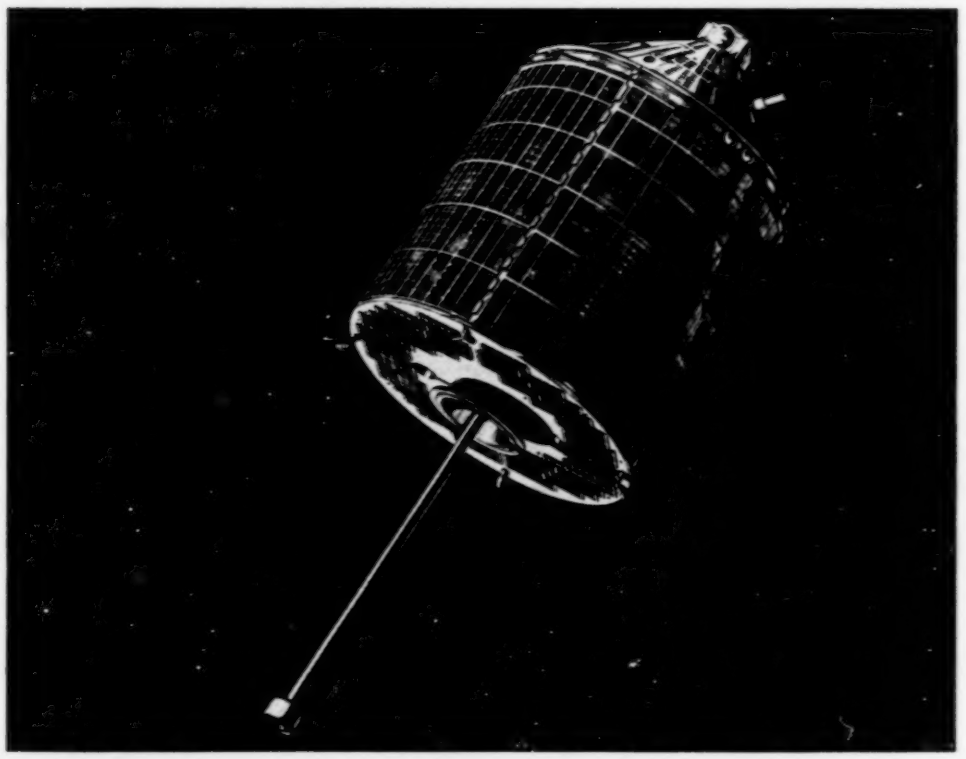
Like antenna system II, the new antenna system will be without a radome; its mechanical design also follows that of system II. In contrast to system II, however, a simple horn exciter similar to the feed system on antenna system I has been selected. This system requires an operating cabin which moves with the azimuth of the antenna and in which are housed the low-noise pre-amplifiers and the steering equipment. Since the antenna system will be unmanned, this arrangement will not cause any difficulty.

The electrical characteristics of antenna system III are adapted to the requirements of the *Intelsat* system. The characteristics of the simple horn exciter of the antennae are very favourable from the standpoint of insulation by crossed polarization and ellipticity in the case of circular polarization. This is of great importance in case of the possible re-utilization of frequencies by the systems which succeed *Intelsat-IV*.



Antennae 1 and 2 at the Raisting earth station, Federal Republic of Germany

(Bundesministerium für das Post- und Fernmeldewesen)



The Azur *satellite* (Bolow, Munich)

The drive mechanism of the new system is suitable for operation with stationary satellites. The maximum speed of rotation is 0.3°/s so that the antenna can be switched from one satellite to another in a few minutes.

The *Deutsche Bundespost* proposes to use the Spade demand assignment equipment system because, with a small number of channels and a restricted volume of traffic, the FM/FDM system is not economical. Tenders for a Spade system have been invited and some have been submitted this year.

1.2 Work on the experimental Franco-German *Symphonie* satellite project was also continued in 1970. The delivery order will probably be placed this year with a consortium of French and German firms.

1.3 In connection with satellites, preparations were started in 1969 in the Federal Republic of Germany for a study of propagation conditions above 10 GHz. In 1970 tenders were invited for work on an antenna system suitable for receiving frequencies above 10 GHz and the contract went to a German firm. The antennae diameters will be 8.5 m.

A site has been selected at Leeheim, near Darmstadt. The antenna system will probably be completed in October 1971.

2. Radioastronomy service

At Effelsberg (near Bad Münstereifel), the fully controllable radiotelescope for the *Max-Planck Institut für Radioastronomie* (Bonn) will shortly be completed. It is expected to go into operation in the spring of 1971.

The radiotelescope, weighing 2000 tons, is equipped with a parabolic reflector 100 m in diameter. The centre piece of the reflector is in segments composed of aluminium panels arranged in a honeycomb pattern; around this is a circular ring of plain aluminium plates, and finally, a metal trellis along the parabola to mitigate wind pressure.

3. Space research radio service

3.1 "Azur"

The first *Azur* research satellite, which was launched from the Western Test Range on 8 November 1969 by a *Scout* launcher, operated practically faultlessly until 28 June 1970. Its purpose was to make measurements inside the radiation belt of the polar auroras during protonic solar events. During its mission it

was monitored by the *Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt* (German Research and Test Centre for Air and Space Travel) at Oberpfaffenhofen.

3.2 "Dial"

On 10 March 1970, the *Dial* upper atmosphere research satellite built by German industry was placed in a highly eccentric elliptical orbit from the launching pad of the CNES (French National Space Research Centre) near Kourou, French Guyana, by a French *Diamant-B* launcher.

The satellite weighs 60 kg and is intended for measuring temporal and spatial changes in upper air conditions. Some of its tasks are to study the earth's corona and record electronic density and high-energy particles in the upper atmosphere near the equator.

3.3 "Aeros"

The second German research satellite, which will probably be launched in the summer of 1972 by an American *Scout*-type launcher, is the *Aeros* upper atmosphere satellite. The *Aeros* project will give a group of German and American scientists an opportunity to explore the upper atmosphere.

The project will be carried out by the Federal Republic of Germany in co-operation with NASA, United States. The Federal Republic of Germany is responsible for developing and building the satellite, and for the necessary earth operating equipment and the scientific measuring instruments for the German experiments. In addition, the Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt will be responsible for operating and controlling the satellite during its six-month mission.

NASA is mainly responsible for providing the launcher, carrying out the launching and controlling the satellite and the orbit measurements during the initial phase from NASA's network of earth stations.

3.4 "Helios"

Two solar probes are being developed under the German-American solar probe project, the agreement for which was signed by the two countries on 10 June 1969. These are intended to provide, from the perihelium, scientific data about interplanetary space and the outer zones of the solar corona.

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND, THE CHANNEL ISLANDS AND THE ISLE OF MAN

A. Satellite communications

a) Operational activities

Goonhilly No. 2 aerial transferred service on 1 February 1970 to the newly launched *Intelsat-III F6* following serious trouble experienced with the de-spun aerial of the *Intelsat-III F2* satellite positioned over the Atlantic Ocean.

A further transfer was necessary in May 1970 when an additional *Intelsat-III* was emplaced over the Atlantic. The introduction of the second operational satellite *F7*, was necessary to meet the growing demand for circuits from existing and new earth stations. With this transfer Goonhilly resumed its contact with the original United States earth station at Andover, Maine, which since ceasing operations to *Intelsat-I (Early Bird)* has been re-equipped for *Intelsat-III* operations. The Etam, West Virginia, station remained operating to the *F6* satellite.

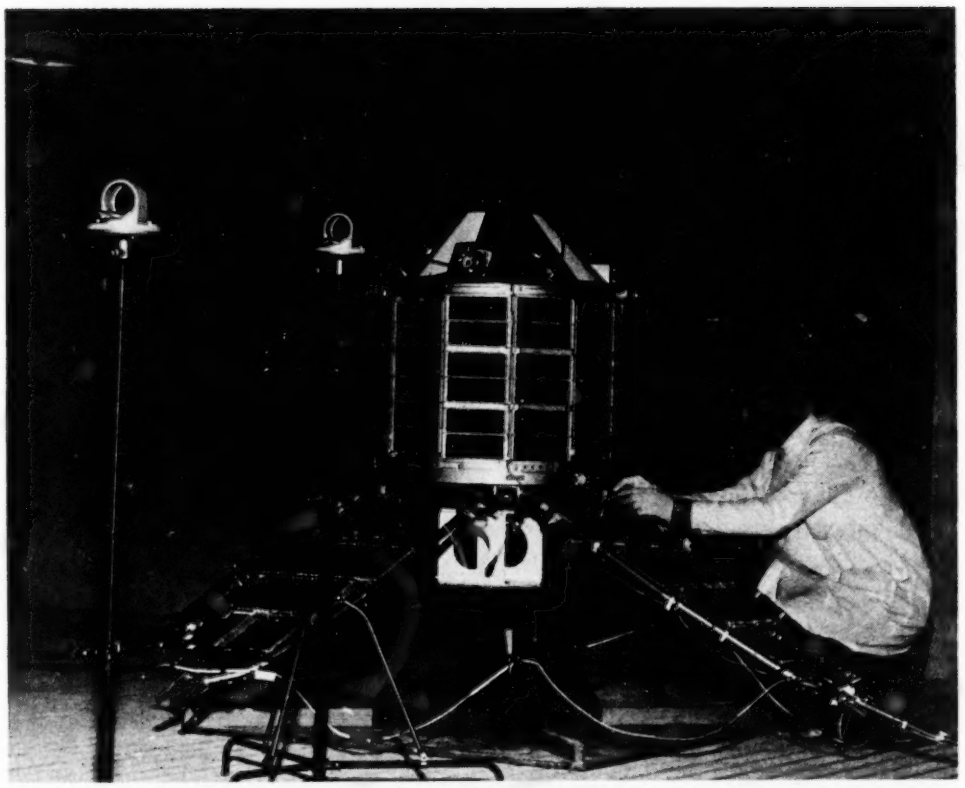
1) During 1970 the United Kingdom commenced direct satellite service with Greece and Morocco via the Atlantic Ocean satellite and via the Indian Ocean satellite with Malaysia, Thailand and the East African earth station in Kenya which also provides direct service with Tanzania and Uganda. Until the introduction in the Indian Ocean region of the Hong Kong and Singapore earth stations, service with Hong Kong has been established through the Australian earth station at Ceduna and the *Seacom* cable. Service with Singapore is via the Malaysian station at Kuantan.

2) Direct service between the United Kingdom and Mexico and Panama commenced in 1970 via European earth stations operating to the *F6* satellite.

3) With the transfer of Lebanon-United Kingdom service to a new submarine cable in the Mediterranean, satellite operations between Goonhilly No. 2 and the Arbaniyeh station ceased in October 1970.

4) By November 1970 the United Kingdom had 234 direct telephone circuits via the Atlantic Ocean and 77 via the Indian Ocean satellites. Additionally 58 circuits were carried by the Goonhilly station for other administrations.

5) In the Overseas Territories for whose international relations the United Kingdom is responsible, Cable and Wireless Limited are currently operating two earth stations and have a third under construction. The Ascension Island earth station works into the Atlantic Ocean region *Intelsat-III* satellite and is used primarily for NASA communications. The Hong Kong I earth station operates in the Pacific Ocean region *Intelsat-III* satellite zone. By the end



Underground tests for British spacecraft—In an air-conditioned cavern deep in the Mendip Hills a prototype of UK-4, *Britain's next scientific satellite, is photographed during radio noise trials, conducted by British Aircraft Corporation, Space Systems Group*

(BPO)

of 1970 Hong Kong I was working to Australia, Japan, South Korea, Thailand and the United States and by the middle of 1971 it is expected to work also to New Zealand. The earth station is presently equipped to work to eight destinations but can be further equipped to work to a total of twelve destinations.

6) The Hong Kong I earth station has been designed to withstand typhoon conditions of winds up to 336 km per hour when the 32 m diameter dish is "parked" in a horizontal position. The earth station can also operate successfully in winds of up to 110 km per hour.

7) The second earth station to be operated by Cable and Wireless in Hong Kong is now under construction and is planned to come into service during the third quarter of 1971. This station will have the same facilities as Hong Kong I for withstanding typhoon conditions. It will operate with the Indian

Ocean region satellites *Intelsat-III* and *IV* and initially will work to Bahrain, East Africa, India, Indonesia, Pakistan (West) and the United Kingdom.

b) Goonhilly earth station — third aerial system

Marconi Communication Systems Limited have been awarded a contract worth just over £2 000 000 pounds sterling by the United Kingdom Post Office for construction and installation of a third aerial system at Goonhilly for operation with *Intelsat-IV* satellites. The new system will go into service during the second quarter of 1972 and will operate in the Atlantic Ocean region with the facility to transmit 3 telephony carriers and receive 22 telephony carriers. Provision will also be made to transmit and receive television on 525 or 625 line systems.

Unlike its predecessors, Goonhilly No. 3 aerial will have a high level azimuth bearing, using a king-post design and easily replaceable nylon and PTFE bearing pads. The high level apparatus room will provide convenient access to the low noise amplifiers which are to be mounted on a level floor and will not tilt as the 32 m diameter aerial reflector is elevated. Four high-power transmitters, using wideband travelling wave tubes, will be provided initially but space will be available

United Kingdom Post Office Training Courses — International and Maritime Telecommunications Region Engineering Training School—Overseas students undertaking practical work associated with the earth station principles and practice course

(BPO)

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for a fifth transmitter to be added later. In the receiving direction, frequency conversion is achieved in two stages, thus avoiding the need to re-tune filters if carrier frequencies are changed. Wide band SHF waveguide connections are being used between the aerial and down converting equipment in the central building but coaxial cables will link the modulators in the central building with up converters housed on the aerial. The new system will be controlled from an extension of the existing consoles in the central building.

c) Propagation studies

During 1970 a steerable offset Cassegrain antenna of 6 m diameter aperture was commissioned for experimental work related to satellite system propagation studies in the frequency band 10-40 GHz. It is expected that this antenna will be used for tests in conjunction with the Italian *Sirio* satellite.

Measurements of antenna noise temperature at 4, 11.75 and 17 GHz at elevation angles of 5° and 20° have been continued through the year, and a report on the results so far obtained was given to the Earth Station Technology Conference, held under the auspices of the Institution of Electrical Engineers (IEE), 14-16 October 1970.

Measurements using a 12 GHz solar radiometer, set up to measure atmospheric attenuation for a range of elevation angles, have also continued. The analyzed results for all these measurements of attenuation and antenna noise have been made available to the CCIR.

d) Ship-to-shore tests via satellite

In the later part of 1970, allocations in the test schedules of the *ATS-III* satellite at present situated over the Atlantic were made available by NASA to the United Kingdom. The Post Office and other interested parties made use of the test periods for VHF communication experiments between a container ship, the *Atlantic Causeway* and a mobile station located at Burnham, Somerset. Transmissions included frequency modulation telephony with and without speech processing (i.e. compandors and Lincompex) double sideband suppressed carrier amplitude modulation telephony, data and facsimile. The results are being evaluated.

e) CCIR work and preparation for WARC-ST

Under the leadership of the Ministry of Posts and Telecommunications, the United Kingdom has been preparing during 1970 for the World Administrative Radio Conference on Space Telecommunications (WARC-ST) which is to commence in June 1971. The United Kingdom regards this Conference as of the greatest importance for the future development of all uses of outer space since adequate regulatory provision must be made for space radio needs for the next decade, in harmony with terrestrial radio services. The United Kingdom has

submitted some 28 contributions to the CCIR Special Joint Meeting of Study Groups to be held in February 1971 which will deal with technical problems in preparation for the Space Conference.

A second meeting of CCIR International Working Party 4/1 (which the United Kingdom chairs), attended by representatives of eight countries, was held in the Post Office Telecommunications Headquarters, London, from 19-23 October 1970. The subject under study by the Working Party was "Technical factors influencing the efficient use of the geostationary satellite orbit by communications satellites sharing the same frequency band". Some 50 documents were considered by the Working Party, 9 of which were submitted by the United Kingdom. A report has been issued for distribution by the CCIR.

A meeting of Interim Working Parties of CCIR Study Group 5 (Propagation in non-ionized media) took place in Nice in December 1970, under a United Kingdom Chairman, to prepare data on tropospheric propagation relevant to the Space Conference. About 35 relevant documents were considered, 18 of which were submitted by the United Kingdom.

f) European telecommunications satellite project

The United Kingdom has participated actively in studies performed within the framework of the European Space Conference (ESC) by representatives of the ESC, the European Space Research Organisation (ESRO), the European Conference of Postal and Telecommunications Administrations (CEPT) and the European Broadcasting Union (EBU). The studies have been concerned with the development of a European satellite system for telephony and television. Following some initial proposals in March by the Working Group "European Communication Satellites", the ESC entrusted to ESRO the primary development tasks and made money available to ESRO for the first year's industrial experimental work. Following a further ESC decision a special Working Group was set up within CEPT in September, for the principal purpose of collaborating with ESRO in this project and representing CEPT interests. A permanent Sub-Group has been established to carry out most of the work on behalf of CEPT. The United Kingdom is supplying one of the five members of this Sub-Group, which spends part of its time assisting ESRO in the drafting of contract specifications for European industry and in the evaluation of the industrial tenders.

g) Meteorology

The Meteorological Office continues to receive broadcast transmissions from United States weather satellites equipped with automatic picture transmission (APT) cameras. In addition to the normal daytime cloud cover pictures, nighttime infra-red pictures are being received and used operationally.

h) Earth Station Technology Conference

In October 1970 a three-day Conference was held in London sponsored jointly by the Institution of Electrical Engineers (IEE), the Institute of Electrical and Electronics Engineers (IEEE) and the Institution of Electronics and Radio Engineers (IERE), on the subject of earth station technology. The Conference provided an opportunity for engineers from all over the world to review the current situation in the design of earth stations and to discuss the way earth stations will develop in the future. There were 396 participants in the Conference, of whom 182 were from overseas. A total of 69 papers was presented.

j) Consultancy services — United Kingdom Post Office and Crown Communications

The United Kingdom Post Office has accepted an invitation to act as consultants to the Zambia Post Office for a project which includes a satellite earth station and other telecommunications installations. The work on the earth station project will be carried out through Crown Communications which comprises the United Kingdom Post Office and the Crown Agents and which also provided extensive services in connection with the satellite communications earth station being built by the Government of Singapore.

A visit was paid to Zambia in September 1970 for discussions with the Zambia Post Office and to inspect prospective sites for the earth station.

k) United Kingdom Post Office training courses

The United Kingdom Post Office continued to provide courses for technicians in the principles and practice of satellite earth station operation at its Engineering Training School at Leafield near Oxford. Three courses (with appropriate "lead-in" training) were undertaken during 1970. The courses are intended for United Kingdom Post Office and Cable and Wireless Limited technicians and also for staff from overseas administrations. Twelve students can be accommodated on each course. Similar courses are being organized for 1971 and there is a steady demand for places but a few remain to be allocated.

B. Space research relevant to radiocommunications

1. Various studies from the ground, from sounding rockets launched in the national programme and from United Kingdom experiments carried by ESRO sounding rockets and satellites have all during the year contributed useful scientific information which has a bearing on radiocommunications.

2. A new satellite at present known as *UK-4* is under preparation for launch by NASA in late 1971. It will have an integrated payload to study the interactions between the plasma, electromagnetic waves and charged particle streams in the topside of the ionosphere. This data will supplement that already utilized from *Ariel-III* for the improvement of ionospheric predictions.

Ship-to-shore tests via satellite — A crossed-Yagi aerial array was used on the Atlantic Causeway. *Its broad beamwidth eliminated the need for stabilization against the ship's movement*

(BPO)

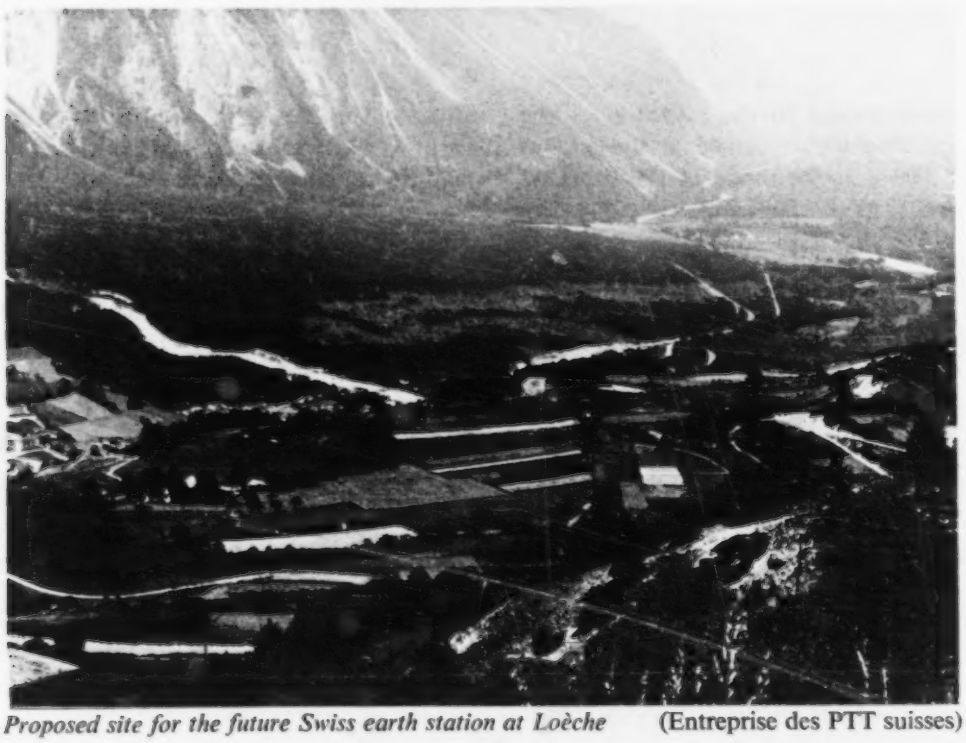
3. The radio and space research station at Slough is participating in the Italian *Sirio* project, in collaboration also with the United Kingdom Post Office, by which the propagation of millimetre radio waves between a satellite and earth will be studied. The station will be particularly interested in meteorological influences, in space-diversity reception on the ground, and in frequency dispersion in wideband transmissions.

4. Millimetre-wave radiometer measurements of radiation from the sun, and of atmospheric noise temperature, are also providing data relevant to the influence of meteorological factors, notably precipitation, on radiocommunication links.

5. Another new study is that of ionospheric scintillation effects on earth-space links at frequencies as high as 400 MHz.

SWITZERLAND (CONFEDERATION OF)

A geotechnical survey has now been completed on the siting of the Swiss earth station. The location proposed by the specialists is near Loèche in the Valais on a plateau 920 m high overlooking the Rhone valley.



Proposed site for the future Swiss earth station at Loèche (Entreprise des PTT suisses)

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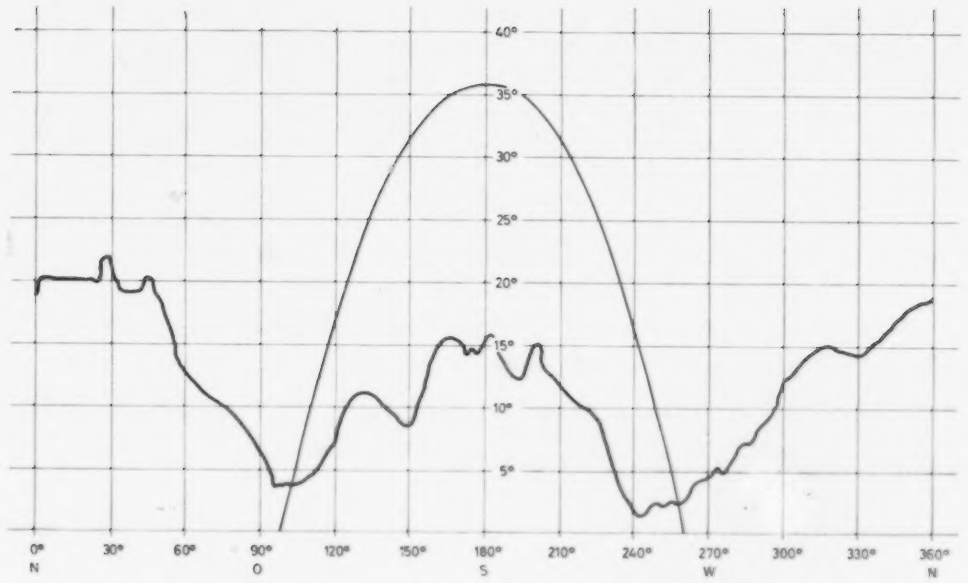

Horizon around the future Swiss earth station and geostationary orbit

(Entreprise des PTT suisses)

With respect to the selection of the contractor for the earth station, the preliminary bids received at the end of 1969 have been examined and a decision is about to be made of the firms which will be asked to submit definitive proposals at the beginning of 1971.

TURKEY

In 1970, the administration carried out a detailed profitability study and other related preliminary studies concerning the construction in Turkey of an earth station for space radiocommunication.

UNION OF SOVIET SOCIALIST REPUBLICS

Telecommunication satellites of the *Molnya-1* series were launched in the USSR on 19 February, 26 June, 29 September and 27 November 1970 to ensure the operation of the long-distance radio-telephone and radio-telegraph services and

1.05

Orbita *network earth station in Alma Ata, Kazakhstan* (APN)

the transmission of the programmes of the Central Television Service of the USSR over the *Orbita* network of stations scattered throughout the most remote and inaccessible regions of the country.

Work on the further development of this network continued and earth stations were completed at the towns of Okha, Zeia, Uraĭ, Sovietskaĭa Gavan and Bilibino. At the beginning of 1971, there will be 35 stations receiving the programme of the Central Television Service relayed by a *Molnya-I* telecommunication satellite. More new stations are being planned and built.

Successful measures were taken in 1970 to improve earth stations further and to make even fuller use of their technical possibilities and those of the space telecommunications network as a whole.

Most of the *Orbita* stations can now receive not only black-and-white but also colour transmissions.

There was a further increase in the number of towns with telephone connections to Moscow via satellite.

As a part of the co-operation between socialist countries in space telecommunications, an earth station was built at Ulan Bator, People's Republic of Mongolia, with the assistance of the Soviet Union, and put into service in February 1970. A technical assistance agreement was also signed with Cuba for the construction of an earth station for satellite telecommunications.

Work has gone on for the establishment of *Intersputnik*, an international space-communication organization and network.

Within the framework of the agreement on technical and scientific co-operation between France and the Soviet Union in space telecommunications, experimental colour television broadcasts by the *Secam* system were made in February, August and September on circuits of the Moscow-Paris space link.

The high-quality colour television broadcasts with sound accompaniment made via the *Molnya-I* satellite during the visit of the President of the French Republic to the USSR in October 1970, were rendered possible by the joint work of Soviet and French experts.

VENEZUELA (REPUBLIC OF)

Earth station

An earth station for satellite communications via the *Intelsat* network was completed and brought into operation in November 1970.

The station was built and is operated and administered by the *Compañía Anónima Nacional Teléfonos de Venezuela* (CANTV), which is responsible, *inter alia*, for the country's commercial communications via satellite.

The station is close to Camatagua in the State of Aragua in the north-central part of the country, 140 km south of Caracas.

General characteristics of the station

The station operates with the *Intelsat* satellites placed over the Atlantic Ocean to serve the region and will be able to work with the future *Intelsat-IV* satellites.

There are four buildings:

a) one for equipment and antenna;
b) one housing the electric power plant;
c) one for administrative offices;
d) one with sleeping quarters.

Main technical characteristics

The Camatagua earth station will be able to operate with *Intelsat-II, III* and *IV* satellites.

a) Capacity of the system:

— initially, 132 speech channels with 1 transmit carrier and 1 television channel: it can be extended to include 2 transmit carriers and 17 receive carriers.

b) Present capacity:

— 60 speech channels, simultaneous correspondence with 10 stations and 1 television channel.

c) Antenna:

— Cassegrain optical system
— diameter of the main dish: 30 m
— azimuth-elevation mount
— movement
  — elevation: $-2°$ to $92°$
  — azimuth: $\pm 180°$
— tracking speed: 0.002 to 0.3°/s
— acceleration: $0.01°/s^2$ to $0.3°/s^2$
— receive gain: (4 GHz) 60 dB
— transmit gain: (6 GHz) 63 dB
— antenna noise temperature (at 5° elevation): less than 50° K

d) Receiving equipment:

— bandwidth: 500 MHz
— frequency: 3700-4200 MHz
— noise temperature: 17° K

— two parametric, helium-cooled amplifiers
— working temperature: (17° K) 256° C below zero
— figure of merit: G/T at 5° elevation with clear sky: 40.7 dB

e) Transmitting equipment:

— bandwidth: 500 MHz
— frequency: 5925-6425 MHz
— nominal output power: 3 kW (saturation power)
— amplifiers: three 3 kW klystron amplifiers; a fourth tube may be added

f) Power supply:

— mains supply: 400 kW, 13.8 kV line, transformation at 240/416
— 2 standby generating units: Diesel, 1800 rpm, 250 kW/312 kVA, power factor 0.8

g) Main continuity system:

— rectifiers-inverters: 50 kW/62.5 kVA
— batteries: 480 Ah/10, 241 V

h) Auxiliary continuity system:

— three 150 A, 48 V rectifiers
— battery: 1080 Ah/8
— battery reserve time
  — for alternating current (inverters):
  — 40 min with 40 kW
  — 7 min with 80 kW
  — for direct current:
  3 hours.

Link with the national telecommunication network

The earth station is connected to the National Telecommunication Centre in Caracas by a microwave system, the main characteristics of which are as follows:

Terminal stations:

— Camatagua (earth station) and
— National Telecommunication Centre, Caracas

Repeater stations:

— Camataguita (active repeater)
— Cerro El Cocuy (passive repeater, 18 × 12 m)
— Cerro El Avila (active repeater)

Operating frequency:

— upper part of 6 GHz band

Transmission power:

— 1 W, Camataguita earth station-El Avila sections
— 10 W, Camataguita-El Cocuy-El Avila section

Radio-frequency channels:

— 3 two-way channels (1 for telephony, 1 for television and 1 common reserve)

Radio-frequency channel capacity:

— 960 telephone channels or 1 television channel

Reliability of the link:

— 99.9%

Repeater power supply:

— commercial network, 1 generating unit, loaders and batteries with 3 hours' reserve.

Correspondents

Initially, communications via satellite are being made with the following countries: Argentina, Canada, Germany, Italy, Mexico, Panama, Spain and the United States.

Cost of the system

The cost of constructing the station and the link system and bringing them into service amounted to approximately 22 million bolivars; this includes public works, equipments, transport, installation of measuring equipment, training, operation and maintenance for three months and spare parts for two years.

ANNEX 2

Resolution adopted by the United Nations

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Resolution adopted by the General Assembly at its Twenty-Fifth Session

■ **Resolution 2733 (XXV)**

2733 (XXV)

A

International co-operation in the peaceful uses of outer space

The General Assembly,

Recalling its Resolution 2453B (XXIII) of 20 December 1968 whereby it established a Working Group of the Committee on the Peaceful Uses of Outer Space to study and report on the technical feasibility of communication by direct broadcast from satellites and the current and foreseeable developments in this field, as well as the implications of such developments in the social, cultural, legal and other fields,

Taking note with appreciation of the reports prepared by the Working Group during its three sessions,[1]

Noting that a first satellite-borne instructional television experiment for direct reception into community receivers will be undertaken in India as early as 1973/1974, thereby making it possible to enrich life in isolated communities,

Noting that the potential benefits of satellite broadcasting have particular significance with regard to better understanding among peoples, the expansion of the flow of information and the wider dissemination of knowledge in the world, and promoting cultural exchanges,

Recognizing that the use of satellite-borne television for educational and training purposes, particularly in developing countries, can in many instances contribute towards national programmes of integration and community development and economic, social and cultural development in such areas as formal and adult education, agriculture, health and family planning,

Taking note of the concern of the Committee on the Peaceful Uses of Outer Space in considering the practical interests of all States, in particular the interests of the developing countries, concerning the efficient use of the geostationary orbit and the frequency spectrum,

Recognizing that the effective deployment and use of direct satellite broadcasting requires large-scale international and regional co-operation and that further consideration may have to be given to the legal principles applicable in this field,

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[1] *Official Records of the General Assembly, Twenty-fourth Session* — Supplement No. *21A (A/7621/Add. 1)*, annexes III and IV; *A/AC.105/83*

Endorsing the Working Group's conclusions [2] on the applicability to such broadcasting of certain existing international legal instruments, including the Charter of the United Nations, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and the applicable provision of the International Telecommunication Convention and Radio Regulations,

1. *Recommends*, on the basis of the probable patterns of use of satellite broadcasting systems outlined by the Working Group of the Committee on the Peaceful Uses of Outer Space, that Member States, regional and international organizations, including broadcasting associations, should promote and encourage international co-operation on regional and other levels in order, *inter alia*, to allow all participating parties to share in the establishment and operation of regional satellite broadcasting services and/or in programme planning and production;

2. *Draws the attention* of Member States, specialized agencies and other interested international organizations to the potential benefits to be derived from direct broadcast satellite services, especially in developing countries, for improving their telecommunications infrastructure, thereby contributing to general economic and social development;

3. *Recommends*, with a view to making available the benefits of this new technology to countries, regardless of the degree of their social and economic development, that Member States, the United Nations Development Programme and other international agencies should promote international co-operation in this field in order to assist interested countries to develop the skills and techniques that may be necessary for its application;

4. *Requests* the Committee on the Peaceful Uses of Outer Space to keep under review the question of reconvening the Working Group at such time as additional material of substance on which further useful studies might be based may have become available;

5. *Recommends* that the Committee on the Peaceful Uses of Outer Space should study through its Legal Sub-committee, giving priority to the liability convention, the work carried out by the Working Group on Direct Broadcast Satellites, under the item on the implications of space communications;

6. *Invites* the International Telecommunication Union to continue to take the necessary steps to promote the use of satellite broadcasting services by Member States and to consider at the 1971 World Administrative Radio Conference for Space Telecommunications the appropriate provisions under which satellite broadcasting services may be established;

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[2] *A/AC.105/83*, paragraph 69(3)

/ 13.

7. *Requests* the International Telecommunication Union to transmit, when available, to the Committee on the Peaceful Uses of Outer Space all information about the use of the geostationary orbit and the frequency spectrum;

8. *Invites* the United Nations Educational, Scientific and Cultural Organization to continue to promote the use of satellite broadcasting for the advancement of education and training, science and culture and, in consultation with appropriate intergovernmental and non-governmental organizations and broadcasting associations, to direct its efforts towards the solution of problems falling within its mandate.

B

The General Assembly,

Recognizing the importance of international co-operation in developing the rule of law in the exploration and peaceful uses of outer space,

Recalling that in its Resolutions 1963 (XVIII) of 13 December 1963, 2130 (XX) of 21 December 1965 and 2222 (XXI) of 19 December 1966, it requested the Committee on the Peaceful Uses of Outer Space to prepare a draft convention on liability for damage caused by objects launched into outer space,

Recalling further that in its Resolution 2345 (XXII) of 19 December 1967, in which it commended the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, it also called upon the Committee on the Peaceful Uses of Outer Space to complete urgently the draft convention on liability,

Recalling also its Resolution 2453 B (XXIII) of 20 December 1968, in which it requested the Committee on the Peaceful Uses of Outer Space to complete urgently the draft convention on liability and to submit it to the General Assembly at its Twenty-fourth Session,

Recalling further its Resolution 2601 B (XXIV) of 16 December 1969, in which it urged the Committee on the Peaceful Uses of Outer Space to complete the draft convention on liability in time for final consideration by the General Assembly during its Twenty-fifth Session and emphasized that the convention was intended to establish international rules and procedures concerning liability for damage caused by the launching of objects into outer space and to ensure, in particular, prompt and equitable compensation for damage,

Affirming that until an effective convention is concluded an unsatisfactory situation will exist in which the remedies for damage caused by space objects are inadequate for the needs of the nations and peoples of the world,

Aware that various proposals have been submitted to the Committee on the Peaceful Uses of Outer Space and that a number of provisions have been agreed upon, although subject to certain conditions and reservations, in its Legal Sub-committee,

1. *Takes note* of the efforts made by the Committee on the Peaceful Uses of Outer Space and its Legal Sub-committee at their sessions in 1970 to complete the preparation of a draft convention on liability, for submission to the General Assembly at its current session;

2. *Expresses its deep regret* that, notwithstanding some progress towards this objective, the Committee on the Peaceful Uses of Outer Space has not yet been able to complete the drafting of a liability convention, a subject which it has had under consideration for the past seven years;

3. *Affirms* that the early conclusion of an effective and generally acceptable liability convention should remain the firm priority task of the Committee on the Peaceful Uses of Outer Space and urges the Committee to intensify its efforts to reach agreement;

4. *Notes* in this connection that the main obstacle to agreement lies in differences of opinion within the Committee on the Peaceful Uses of Outer Space on two main issues—the legal rules to be applied for determining compensation payable to the victims of damage and the procedures for the settlement of claims;

5. *Expresses the view* that a condition of a satisfactory liability convention is that it should contain provisions which would ensure the payment of a full measure of compensation to victims and effective procedures which would lead to the prompt and equitable settlement of claims;

6. *Urges* the Committee on the Peaceful Uses of Outer Space to make a decisive effort to reach early agreement on texts embodying the principles outlined in paragraph 5 above, with a view to submitting a draft convention on liability to the General Assembly at its Twenty-sixth Session.

C

The General Assembly

Recalling its Resolutions 2600 (XXIV) and 2601 (XXIV) of 16 December 1969,

Having considered the report of the Committee on the Peaceful Uses of Outer Space, [3]

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[3] *Official Records of the General Assembly, Twenty-fifth Session*, Supplement No. *20 (A/8020)*

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Reaffirming the common interest of mankind in furthering the exploration and use of outer space for peaceful purposes,

Recognizing the importance of international co-operation in developing the rule of law in the exploration and peaceful uses of outer space,

Convinced of the need for increased efforts to promote applications of space technology for the benefit of all countries, particularly the developing countries,

Believing that the benefits of space exploration can be extended to States at all stages of economic and scientific development if Member States conduct their space programmes in a manner designed to promote the maximum international co-operation, including the widest possible exchange and practical application of information in this field,

1. *Endorses* the recommendations and decisions [4] contained in the report of the Committee on the Peaceful Uses of Outer Space;

2. *Requests* the Committee on the Peaceful Uses of Outer Space to continue to study questions relative to the definition of outer space and the utilization of outer space and celestial bodies, including various implications of space communications, as well as those comments which may be brought to the attention of the Committee by specialized agencies and the International Atomic Energy Agency as a result of their examination of problems that have arisen or that may arise from the use of outer space in the fields within their competence;

3. *Invites* those States which have not yet become parties to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, and the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space to give consideration to ratifying or acceding to those agreements so that they may have the broadest possible effect;

4. *Reaffirms its belief*, as expressed in its Resolution 1721 D (XVI) of 20 December 1961, that communication by means of satellites should be available to the nations of the world as soon as practicable on a global and non-discriminatory basis, and recommends that States parties to negotiations regarding international arrangements in the field of satellite communication should constantly bear this principle in mind so that its ultimate realization may be achieved;

5. *Welcomes* the intensified efforts of the Committee on the Peaceful Uses of Outer Space to encourage international programmes to promote such practical applications of space technology as earth resources surveying, for the benefit of

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[4] *Ibid.*, chapter II

1.1.6

both developed and developing countries, and commends to the attention of Member States, specialized agencies and interested United Nations bodies the new programmes and proposals to promote international benefits from space applications noted by the Committee in its report, such as the organization of technical panels, the utilization of internationally sponsored education and training opportunities in the practical applications of space technology and the conduct of experiments in the transfer of space-generated technology to non-space applications;

6. *Takes note* of the recommendation [5] of the Scientific and Technical Sub-committee of the Committee on the Peaceful Uses of Outer Space that the travel and subsistence of participants in the technical panels mentioned in paragraph 5 above should be founded by their own governments, but that the United Nations may give timely assistance to exceptional cases within the existing programmes of the United Nations where this appears necessary both to defray costs and to stimulate interest in special areas;

7. *Welcomes* the efforts of Member States to share with other interested Member States the practical benefits which may be derived from their programmes in space technology, including earth resources surveying;

8. *Requests* the Scientific and Technical Sub-committee, as authorized by the Committee on the Peaceful Uses of Outer Space, to determine at its next session whether, at what time and in what specific frame of reference to convene a working group on earth resources surveying, with special reference to satellites, and in so doing to take into account the importance of appropriate co-ordination with the Committee on Natural Resources, established under Economic and Social Council Resolution 1535 (XLIX) of 27 July 1970;

9. *Welcomes* the efforts of Member States to keep the Committee on the Peaceful Uses of Outer Space fully informed of their activities and invites all Member States to do so;

10. *Notes with appreciation* the report of the Expert on Applications of Space Technology [6] concerning the promotion of space applications;

11. *Recalls* the recommendation [7] that Member States give consideration to designating specific offices or individuals within their Governments as a point of contact for communications regarding the promotion of the application of space technology and thereafter inform the Secretary-General of such designations, and urges those Member States which have not yet designated a point of contact to do so;

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[5] *A/AC.105/82*, paragraph 25(7).
[6] *Official Records of the General Assembly, Twenty-fifth Session*, Supplement No. *20 (A/8020)*, annex II
[7] *Official Records of the General Assembly, Twenty-fourth Session*, Supplement No. *21 (A/7621)*, paragraph 25

12. *Takes note* of the report provided by the Secretary-General [8] to the Committee on the Peaceful Uses of Outer Space concerning improved co-ordination of Secretariat activities in the field of outer space;

13. *Endorses* the suggestion [9] of the Scientific and Technical Sub-committee that the Secretary-General should bring to the attention of Member States all relevant documents relating to applications of space technology submitted to the Sub-committee by Member States, the United Nations, the specialized agencies and other bodies;

14. *Approves* the continuing sponsorship by the United Nations of the Thumba equatorial rocket launching station and the CELPA Mar del Plata station and recommends that Member States should give consideration to the use of these facilities for appropriate space research activities;

15. *Notes* that, in accordance with General Assembly Resolution 1721 B (XVI) of 20 December 1961, the Secretary-General continues to maintain a public registry of objects launched into orbit or beyond on the basis of information furnished by Member States;

16. *Endorses* the recommendation [10] of the Committee on the Peaceful Uses of Outer Space that the Secretary-General be requested to issue an index of existing international instruments (conventions, treaties and agreements) relating to or bearing upon broadcasting satellite services;

17. *Requests* the specialized agencies and the International Atomic Energy Agency to furnish the Committee on the Peaceful Uses of Outer Space with progress reports on their work in the field of the peaceful uses of outer space, and to examine and report to the Committee on the particular problems which arise or which may arise from the use of outer space in the fields within their competence and which should in their opinion be brought to the attention of the Committee;

18. *Requests* the Committee on the Peaceful Uses of Outer Space to continue its work as set out in the present resolution and in previous General Assembly resolutions, and to report to the General Assembly at its Twenty-sixth Session.

D

The General Assembly

Concerned over the devastating harmful effects of typhoons and storms in various parts of the world, particularly in Asia,

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[8] *Ibid., Twenty-fifth Session*, Supplement No. 20 *(A/8020)*, annex III
[9] *A/AC.105/82*, paragraph 23(3)
[10] *Official Records of the General Assembly, Twenty-fifth Session*, Supplement No. 20 *(A/8020)*, paragraph 55

1.1.8.

Believing that man's present scientific and technical capabilities that have conquered space could help conquer this environmental scourge,

Recalling its Resolutions 1721 (XVI) of 20 December 1961 and 1802 (XVII) of 14 December 1962, and noting work being undertaken and progress achieved in response to them, as reported by the World Meteorological Organization in its annual reports to the Committee on the Peaceful Uses of Outer Space,

Noting further the co-ordinating role in this field of the joint World Meteorological Organization-Economic Commission for Asia and the Far East Typhoon Committee, the discussions on this subject held in that forum and the recent decision to transfer the Typhoon Committee Secretariat to Manila,

1. *Recommends* to the World Meteorological Organization that it take, if necessary, further appropriate action for mobilizing capable scientists, technologists and other pertinent resources from any or all nations towards obtaining basic meteorological data and discovering ways and means to mitigate the harmful effects of these storms and remove or minimize their destructive potentials;

2. *Calls upon* Member States to exert efforts within their means to implement fully the World Weather Watch Plan of the World Meteorological Organization;

3. *Requests* the World Meteorological Organization to submit a report through the Secretary-General to the Committee on the Peaceful Uses of Outer Space at its next session, and to such other United Nations bodies as may be appropriate, on the steps taken pursuant to this and other resolutions.